DOCUMENT RESUME

ED 382 173 IR 017 109

AUTHOR	Brubaker, Thomas, A., Ed.; And Others
TITLE	The Magic of Technology, NECC 1993. Proceedings of the Annual National Educational Computing Conference (14th, Orlando, Florida, June 27-30, 1993).
INSTITUTION	National Educational Computing Conference.
REPORT NO	ISBN-1-56484-043-3
PUB DATE	93
NOTE	362p.; For 1992 proceedings, see ED 356 754.
PUB TYPE	Collected Works - Conference Proceedings (021)
EDRS PRICE	MF01/PC15 Plus Postage.
DESCRIPTORS	Computer Literacy; Computer Networks; *Computer Uses in Education; Distance Education; *Educational Technology; Electronic Mail; Elementary Secondary Education; Global Education; Hypermedia; Laboratory Equipment; Learning Resources Centers; Local Area Networks; Management Information Systems; *Multimedia Materials; Special Needs Students; *Student Projects; *Teacher Education; Telecommunications; Thinking Skills

ABSTRACT

These conference proceedings address the capabilities of technology in education. Papers and summaries of presentations are provided on the following topics: programs for special needs students; virtual realities; funding opportunities; videodiscs; future programs and perspectives; telecomputing; computer networks in the classroom; human infrastructures and interfaces; creating schedules with artificial intelligence; a management information system; a classroom instructional technology center; teacher training; student response journals; teachers and telecommunications; interactive electronic learning; integrating multimedia applications; exploring native cultures; implementation strategies; multimedia lesson planning tools; multimedia and hypermedia projects; electronic mail; global learning; local area networks; gender-free perspectives; for-profit schools; computer simulation of laboratory instruments; connecting students and the community; multimedia for bilingual children; technology leadership in school library media specialists and school administrators; electronic versus print textbooks; distance education; online systems selection; empowering students; computer literacy; information needs; musical and artistic applications; teaching and learning with technology in the classroom; research and development; international perspectives; rights and responsibilities for electronic learners; environmental awareness; critical thinking; collaborative learning; desktop publishing; restructuring; and improving student performance. In addition, the NECC '93 committees and the NECA Board of Directors and Committee are listed. Subject and presenter indexes are also included. (AEF)

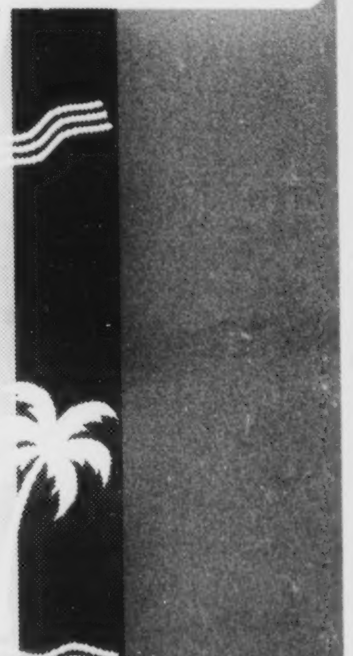
****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)
☐ This document has been reproduced as received from the person or organization originating it.
☐ Minor changes have been made to improve reproduction quality.
● Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED 382 173

Proceedings

The Magic of Technology



NECC '93
June 27–30, 1993
Marriott's Orlando World Center
Orlando, Florida

Hosted by the University of Central Florida
College of Education

"PERMISSION TO REPRODUCE THIS MATERIAL HAS BEEN GRANTED BY
Donella Ingham
TO THE EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)."

IR017109

BEST COPY AVAILABLE

Proceedings

NECC '93
June 27–30, 1993
Orlando, Florida

Hosted by the University of Central Florida
College of Education

NECC '93 Proceedings

ISBN: 1-56484-043-3

© 1993, NECC

NECC '93 Proceedings Production Team
Thomas A. Brubaker, Editor
Mary Bird
Lynn Cullum
Donella Ingham
Lori Novak

For the
National Educational Computing Conference
June 1993

Foreword

Welcome to the fourteenth annual National Educational Computing Conference—NECC '93! As the theme of NECC '93 is **The Magic of Technology**, we can think of no more appropriate gathering site than Orlando, Florida, one of the most magical of all destinations. We want to take this opportunity to welcome each and every one of you to the conference. Many of you have come great distances to be here, and we hope you will find NECC '93 to be as enjoyable a time as it is informative.

The theme of this conference refers to the enabling capabilities of computers and related technologies. NECC '93 celebrates your ability and willingness to embrace technology in all of the forms it may take and to apply it to the most wondrous and magical of all endeavors—education. The wonders you will encounter here at NECC '93 range from the familiar to the unfamiliar.

The Proceedings are designed to serve as your guide to the myriad of sessions and presentations offered at NECC '93. While it is not possible to attend all of them, the Proceedings offer short abstracts of the Poster, Project, Society, and Spotlight sessions. In addition, all of the papers presented at this conference are printed in their entirety. It is our hope that you will use these Proceedings even after NECC '93 is over, perhaps to recall an interesting session you attended, to gain more information about a particular strategy or concept that interests you, or to contact a presenter. We are particularly excited to offer these Proceedings for the first time in **three** formats: paper, diskette, and CD-ROM. Whichever form you are using, we hope you will find it beneficial and "user friendly."

This conference didn't happen by magic. Many, many people have dedicated many, many hours to making this a very special event for you: the Conference and Program Committees and subcommittees; the NECA Board and Committee; the NECC staff at ISTE and at the University of Central Florida; the UCF College of Education faculty and staff; the instructional technology supporters at the Florida Department of Education and the Florida Board of Regents; and the many administrators, faculty and staff members at UCF and area schools who supported this conference in many ways.

Thanks to Paul Katz and his able assistants for organizing the exhibits and security. Many exhibitors have provided sponsorship of this conference through equipment, software, expertise and technical support, and dollars.

A special word of appreciation to each of the presenters, presiders, workshop leaders, and volunteers who gave of their time and knowledge. Finally, our heartfelt appreciation to our families who have had so little of our time for so long.

During NECC '93 and after, we invite you not only to celebrate the magic of technology, but to believe in it, and to make it happen for students!

Donna J. Baumbach
NECC '93 Conference Chair
University of Central Florida
Orlando, FL

William Bozeman
NECC '93 Program Chair
University of Central Florida
Orlando, FL

Table of Contents

NECC '93 Conference Committees .... *ii*

NECA Board of Directors and Committee .... *iii*

Sponsoring Societies .... *iv*

Reviewer Acknowledgements .... *ix*

Table of Contents by Day .... *x*

Monday Proceedings *1*

Tuesday Proceedings *109*

Wednesday Proceedings *243*

Presenter Index *323*

Subject Index *327*

NECC '93 Committees

Conference, Donna J. Baumbach
University of Central Florida

Program, William Bozeman
University of Central Florida

Treasurer, Doug Brumbaugh
University of Central Florida

Corporate Partnerships, David Brittain
Florida Department of Education

Registration, Carol McRae
McRae and Company

Local Arrangements, Sally Brewer
University of Central Florida

Exhibits, Paul Katz
University of Oregon

Hospitality, Kathy McKinney
Tropical Elementary School

Study/Recreational Tours, Chris Carey and Gene Bias
Edgewater High School

Social and Special Events, Sherie Bargar
Maitland Middle School

Golf Tournament, Bill Branch
University of Central Florida

Headquarters Office, Ann Kohler
Lyman High School

Graphics, Mary Bird
University of Central Florida

Publicity, Jorge Ortega
Florida Department of Education

Equipment, Barry Pitsch and Vaughn Murphy,
Heartland AEA
Jerry Ewing, University of Central Florida

Access and Equity, Kathy McWhorter
Florida Department of Education

Presiders, Saul Klein and Maureen Klein
Brevard County Schools

Workshops, Alice Ray-Overstreet
Polk County Schools

Keynote Sessions, Mike Eason
Florida Department of Education

Society Sessions, Nancy Roberts
Lesley College

Spotlight Sessions, Rita Oates
Dade County Schools

Speaker Ready Room, Eileen Pracek
Florida Diagnostic & Learning Resources System

Volunteers, Lynn Cullum
University of Central Florida

Proceedings, Thomas A. Brubaker
University of Central Florida

Final Program, Barbara Ann Cox
Florida Department of Education

Arts in the Afternoon, Jerry Gardner
University of Central Florida

Vendor Sessions, Gary Becker
Seminole County Schools

Papers, B. R. Black
Polk County Schools

Projects K-12, Dale Brushwood
Orange County Schools

Birds-of-a-Feather, Ivy Montoya
Dade County Schools

First-Timers' Events, Judy Ambler
Pinellas County Schools

ISTE Representative, Anita Best

NECC Conference Coordinators,
Susan Gayle and Donella Ingham

Conference-On-Disk, Dan Lampert
Techware

NECC Administrative Assistants,Amy Milholland,
Rebecca Cinci, Marion Bowling, Peggy Kay
University of Central Florida

NECA Board of Directors & Committee

Ronald E. Anderson - ACM/SIGCAS
University of Minnesota

Donna Baumbach - Conference Chair, NECC '93
University of Central Florida

Bill Bozeman - Program Chair, NECC '93
University of Central Florida

David Brittain -Director
Florida Department of Education

Ricky Carter - Program Co-Chair, NECC '94
Bolt, Beraneck and Newman

Steven W. Gilbert - EDUCOM
Washington, D. C.

Diana Harris - Secretary
University of Iowa

Jan Hawkins, Program Co-Chair, NECC '94
Bank Street College

James Kerlin - ACM/SIGUCCS
Pennsylvania State University

John Lawson - ACM/SIGCUE
University of Oregon

Jesse C. Lewis - ECMI
Norfolk State University

Doris K. Lidtke - Past Chairperson
National Science Foundation

Bonnie Marks - ISTE/SIGTC
Alameda County Office of Education

Gail Miles - CCSC
Lenoir-Rhyne College

Jean Moon - Conference Co-Chair, NECC '94
Lesley College

Mike Mulder - IEEE Computer Society
University of Southwestern Louisiana

Cathleen Norris - Director and
Conference Chair, NECC '92
University of North Texas

James L. Poirot - President
University of North Texas

John Richards - Conference Co-Chair, NECC '94
Bolt, Beranek and Newman, Inc.

Nancy Roberts - Vice President
Lesley College

R. Waldo Roth - ASCUE
Taylor University

Sally Sloan - ISTE
Winona State University

Ted Sjoerdsma - Treasurer
Washington and Lee University

Harriet Taylor - Program Chair, NECC '92
ACM/SIGCSE
Louisiana State University

Joe Turner - Director
Clemson University

Michael Zastrocki - CAUSE
Boulder, CO

Stanley Zenor - AECT
Washington, D. C.

Sponsoring Societies

ACH—Association for Computers and the Humanities

The Association for Computers and the Humanities (ACH) is an international organization devoted to encouraging the development and use of computing techniques in humanities research and education. Traditionally, ACH has fostered computer-aided research in literature and language, history, philosophy, anthropology, and related social sciences as well as computer use in the creation and study of art, music, and dance. As computing applications in the humanities have developed and broadened in the 1980s, the Association has expanded it scope to include areas from word processing to computer-assisted instruction in composition, language, history, philosophy, and anthropology, as well as computational linguistics and cognitive science, which overlap increasingly with work in the area of humanities computing.

Founded in 1977, ACH is the primary professional society for humanists who are involved or interested in any aspect of humanities computing. The Association provides a forum for continuing communication about humanities computing and strives to meet the needs of those who want to gain familiarity with both existing and potential applications of computers in humanities disciplines.

The heart of ACH is its quarterly newsletter, which covers the activities of the Association and its members and includes articles on various areas within humanities computing, news of projects and conferences of interest to ACH members, and reports on activities of governmental agencies and other organizations that affect computer-aided humanities research.

Computers and the Humanities, published by Paradigm Press, is a quarterly journal devoted to scholarship in the field of humanities computing. Subscription to *CHum* is included in the ACH membership fee.

ACH sponsors the biannual International Conference on Computers and the Humanities (ICCH), held in odd-numbered years, which brings together scholars from around the word to report on research activities and software and hardware developments in the field. Recently, ACH began to sponsor conferences and workshops on specialized topics in humanities computing, held in even-numbered years.

SIGCAS—ACM Special Interest Group on Computers and Society

SIGCAS is the Association for Computing Machinery's Special Interest Group on Computers and Society. With a membership of nearly 1,200, this professional group seeks to identify social issues raised by computer technology and to provide a forum for discussion on how to approach these issues.

SIGCAS publishes a quarterly newsletter, *Computers and Society*, which is a primary source of material on this topic. As a vehicle of communication for the SIGCAS membership, it includes news, comments, and articles on any societal issues raised by computing technology. One of the few periodicals on this subject, it provides a flexible and timely forum for important, evolving topics, such as data quality, employment, and intellectual property rights.

According to a recent membership survey, about 40% of SIGCAS members teach course material on computers and society. In recent years SIGCAS has organized sessions at computer conferences on topics such as computer ethics and organizational impacts of computers.

Contact: *Ron Anderson, 663 Bushaway Road, Wayzata, MN 55391*
(612) 624-9554

SIGCSE—ACM Special Interest Group on Computer Science Education

SIGCSE became a special interest group of ACM in 1970. It currently consists of over 2000 members from the educational, industrial, and governmental communities interested in various aspects of computer science education. SIGCSE has goals of encouraging and assisting in the development of effective academic programs and courses in computer science and promoting research in computer science education.

The following are objectives of SIGCSE:

1. To provide a continuing forum for discussion of common problems among education and other computer scientists through organized meetings and symposia.
2. To publish a bulletin at least quarterly containing information aimed specifically at those interested in computer science education.
3. To work closely with the Education Board of ACM to insure implementation of effective education programs by the Association.

Contact: *Harriet Taylor, Computer Science Department, Louisiana State University, Baton Rouge, LA 70803-4020*
(504) 388-1495

SIGCUE—ACM Special Interest Group on Computer Uses in Education

SIGCUE provides a forum for the discussion of ideas, methods, and policies related to all aspects of computers in the educational process. Established in 1969 its membership (over 1,400 persons) comes from many countries and numerous, diverse institutions and businesses.

SIGCUE publishes a newsletter titled the SIGCUE *Outlook*. Recent topics have included Preservice Education in Educational Computing, International Reports on Educational Computing, and a Teacher Training Curriculum Project. SIGCUE also sponsors and organizes technical sessions at ACM annual meetings, the National Educational Computing Conference, and other national and regional meetings of interest to its members.

Among SIGCUE's goals are (1) helping to bring the technical expertise within ACM to bear upon educational compting generally, (2) cooperating with other special interest groups or educational societies to promote attention to educational computing issues, and (3) providing written and verbal forums for members and the educational community to exchange ideas concerning computer uses in education.

Contact: *John Lawson, 1199 N. Terry, Sp 328, Eugene, OR 97402*
(503) 688-6802

SIGUCCS—ACM Special Interest Group on University and College Computing Services

SIGUCCS provides a forum for those involved in providing computing services on a college or university campus. The topics addressed by SIGUCCS include managing campus computing, computing as it relates to the overall goals of the institution, and the state-of-the-art in various types of college and university computing services, and provides opportunities to discuss and share ideas and experiences with others.

Two annual conferences are regular activities of SIGUCCS. The Computing Center Management Symposium addresses the many aspects of managing computing on campus. This includes hardware, software, planning, finances, and personnel, to name few. The User Services Conference deals more directly with the delivery of particular services to the higher education community. Tutorials on relevant issues are held at both conferences.

In other projects, SIGUCCS offers a Peer Review of the university computing function. Upon request of the computer center director, members of SIGUCCS will formally analyze and comment on different areas of the campus computing function. SIGUCCS also publishes a quarterly newsletter. We consider the newsletter our most important form of communication as it reaches all members and is subscribed to by numerous university computing centers. Conference proceedings are published either as separate documents or as part of the newsletter itself.

Contact: *James Kerlin, 229 Computer Building, Pennsylvania State University, University Park, PA 16802*
(814) 863-0425

AECT–The Association for Educational Communications and Technology

The Association for Educational Communications and Technology (AECT) is an international professional association dedicated to the improvement of instruction at all levels through the appropate use of instructional technology. Founded in 1923, AECT has eveloved as an organization as the technology used in education has eveloved, from the early use of traditional audiovisual media to today's interactive and multimedia technology platforms. AECT members can be found at all levels of public and private education, from elementary schools to colleges and universities, as well as in the corporate and government sectors.

Organizationally, AECT has nine special interest devisions, eight chapters, forty-six state affiliate organizations, and fourteen national and international affiliate organizations. With over 5000 members, AECT is the largest international association for professionals involved in the integration of instructional technology to the learing process. AECT is the United States representative to the International Council for Educational Media.

Tech Trends, in its 37th year of publication, is the Association's professional periodical. Published during the school year, *Tech Trends* features authoritative, practical articles about technology and its integration into the learning environment. *Educational Technology Research and Development*, the Association's research quarterly in its 40th year of publication, is the only refereed journal focusing entirely on research and instructional development in the rapidly changing field of educational technology.

AECT also publishes reference books on a variety of topics, including practical applications of technology, research, copyright, and standards and guidelines for the field of special interest to insructional technologists.

The AECT national convention and exposition is held each year in January or February, drawing over 12,000 participants and exhibitors. Additionally, AECT sponsors an annual professional development seminar focusing on emerging technologies and a leadership development conference for leaders within AECT and its affiliates.

Contact: *Stanley Zenor, 1025 Vermont Avenue, NW, Suite 820, Washington, DC 20005*
(202) 347-7834

ASCUE—The Association of Small Computer Users in Education

The Association of Small Computer Users in Education (ASCUE) is a group of small colleges who work toward continued quality computer education and computer assistance in both administrative and academic areas. The purposes of the organization are: 1) to encourage appropriate uses of computing equipment and techniques for the improvement of its member institutions; 2) to supply its members with information on the most current computing methods; 3) to assist them in solving individual problems; 4) to cooperate with them in the utilization of the various small computers; 5) to cooperate with manufacturers, distributors, and suppliers in establishing and maintaining proper technical standards and in meeting new needs for special devices and systems.

Contact: *Wally Roth, Computing & System Sciences Dept., Taylor University, 500 W. Reade Ave.*
Upland, IN 46989-1001
(317) 998-5269

CCSC–Consortium for Computing in Small Colleges

CCSC is a not–for–profit organization focused on promoting effective use of computing in smaller institutions of higher education which are typically non–research in orientation. It supports activities which assist faculty in such institutions to make appropriate judgments concerning computing resources and educational applications of computer technology.

Because departments in smaller colleges and universities are usually small and not highly specialized, the Consortium encourages the sharing of expertise, effective curriculum patterns, and efficient technological applications.

The Consortium is concerned with the advancement of major programs in both computer science and computer information systems, and with the use of computers in the liberal arts and sciences.

The Journal of Computing in Small Colleges is distributed to faculty in more than 200 colleges across the country. Now in its sixth volume, its five annual issues are averaging 500 pages with articles addressing the broad spectrum of curriculum and computer use in higher education.

Contact: *Gail Miles, Lenoir-Rhyne College, Box 7482, Hickory, NC 28603*
(704) 328-7268

ECMI—Educational Computing in Minority Institutions

ECMI is an organization run by a steering committee representing institutions whose student body reflects a large identifiable minority population. The objectives of ECMI are:

1. Computer literary: To create among the faculty and administrators of the minority institutions an awareness and understanding of the strengths and weaknesses, uses and issues, advantages and disadvantages, feasibility, practicability and limitations of computer applications in all aspects of society, including education.
2. Educational Computing: To narrow the gap which exists between the faculties in minority and non-minority institutions with respect to educational computing know-how and access.
3. Research Computing: To improve the computing facilities available to faculty of minority institutions for research purposes, particularly in those institutions offering graduate programs.
4. Technical assistance—consultants: To provide expert and impartial technical assistance to academic administrators of minority institutions on all phases of academic computing (Instruction and research).
5. Education programs in the computer sciences: To improve the offerings of courses and degree programs in the computer sciences at minority institutions at all levels (e.g., introductory courses, minors, 2-year degree programs, 4-year degree programs, continuing education, graduate programs).
6. Computing facilities: To improve both quality and quantity of computing facilities available in minority institutions, because experience in the non-minority institutions has shown that an adequately staffed and equipped computer center for academic computing is essential to the success of previously stated objectives.
7. Direct student assistance: To increase the availability of minority staff for the computer centers and computer science education programs of minority institutions.
8. The need for a comprehensive program: To facilitate co-ordination and equitable distribution of funded activities to qualified institutions, associations, etc.

Contact: *Jesse C. Lewis, Academic Affairs, Norfolk State University, Norfolk, VA 23504*
(804) 683-8408

EDUCOM

EDUCOM is a nonprofit consortium of colleges, universities, and other institutions founded in 1964 to facilitate the introduction, use, and management of information technology. Through direct services and cooperative efforts, EDUCOM assists its members and provides leadership to the higher education community.

EDUCOM is funded by membership dues, service fees, and grants from foundations, corporations, and government. EDUCOM activities involve over 530 institutions and 90 corporations in the U.S. and abroad. In brief, they are: EDUCOM General Membership; the EDUCOM Consulting Group; EDUCOM Networking Activities including the Networking and Telecommunications Task Force (NTTF) and BITNIC, the BITNET Network Information Center; the EDUCOM Software Initiative; and the Corporate Associates Program.

Contact: *Steven Gilbert, EDUCOM, 1112 16th Street, NW, Suite 600, Washington, DC 20036*
(202) 872-4200

IEEE—The IEEE Computer Society

The Computer Society is the world's largest association of computing professionals, with a total membership of approximately 110,000 computer scientists, computer engineers, and interested professionals. Society membership is open to IEEE members, associate members, and student members and to non-IEEE members who qualify for affiliate membership. An affiliate member is a person who has achieved status in his or her chosen field of specialization and whose interests focus in the computing field.

Every Computer Society member receives *Computer*, a peer-reviewed monthly magazine of general interest to computing professionals which also covers society news and events. Five specialized magazines and five journals are also available to society members as optional subscriptions and to nonmembers, libraries, and organizations.

Magazines published by the Computer Society include *IEEE Computer Graphics and Applications, IEEE Micro, IEEE Design and Test, IEEE Software*, and *IEEE Expert*. Research-oriented journals include *IEEE Transactions on Computers, IEEE Transactions on Software Engineering, IEEE Transactions on Pattern Analysis and Machine Intelligence, IEEE Transactions on Knowledge and Database Engineering*, and *IEEE Transactions on Parallel Distributed Systems*. The Computer Society Press publishes nonperiodical literature, including tutorial texts and conference records. The society's catalog contains approximately 900 titles which are available for purchase.

The society sponsors or cosponsors more than 100 conferences and meetings ranging from workshops and symposia with a few dozen participants to major conferences with many thousands of attendees. Over 30 technical committees offer the opportunity to interact with peers in technical specialty areas, receive newsletters, and conduct conferences and tutorials.

The Computer Society has over 100 local chapters throughout the world, and an additional 100-plus student chapters which provide the opportunity to interact with local colleagues and hear experts discuss technical issues. In addition, tutorials, educational activities, accreditation of computer science and engineering academic programs, the development of standards, and an international electronic mail network all play prominent roles in the society's activities.

Contact: *Mike Mulder, Center for Advanced Computing Studies, University of Southwestern Louisiana, P.O. Box 44330*
Lafayette, LA 70504
(318) 231-6147

ISTE—International Society for Technology in Education

The International Society for Technology in Education, ISTE, is the merged society of the International Council for Computers in Education and the International Association for Computing in Education. ISTE is a non-profit educational organization, with 12,000 individual members and over 60 organization and associate members.

ISTE publishes *The Computing Teacher, Journal of Research on Computing in Education, CÆLL Digest, Microsoft Works in Education, IRM Quarterly*, and books and courseware for persons interested in the instructional use of computers at the precollege level. These publications emphasize teaching about computers, teaching using computers, teacher education, and the impact of computers on curriculum.

ISTE has a substantial and growing professional outreach program. Five major components currently include:

1. Organization Affiliate Members. Members publish newsletters and/or journals, hold conferences, and directly interact with their own members.
2. Professional Staff. ISTE has a professional staff who write, edit, participate in conferences, process orders, consult by phone or mail, etc. *The Computing Teacher* is put together by a full in-house production staff.
3. Ad Hoc Committees. Such a committee created the "ICCE Policy Statement on Software Copyright" and "Code of Ethical Conduct for Computer Using Teachers."
4. Special Interest Groups. ISTE has organized special interest groups for computer coordinators, teachers of educators, computer science educators, Logo-using educators, telecommunications, and hypermedia/multimedia.
5. Independent Study courses. ISTE offers eleven independent study courses carrying graduate credit from the Oregon State System of Higher Education.

6. Private Sector Council. The Council represents a broad range of corporations and services in an advisory capacity to ISTE's Board of Directors.

Contact: *Sally Sloan, Department of Math/Statistics, Gildemeister 322, Winona State University, Winona, MN 55987*
(507) 457-5877

ISTE's SIGTC—The Special Interest Group for Technology Coordinators

The Special Interest Group for Technology Coordinators (SIGTC) is a professional organization that helps technology coordinators meet the challenges of a rapidly changing field. We provide an excellent forum to identify problems and solutions, and share information on issues facing technology coordinators at the precollege level.

SIGTC publishes *SIGTC Connections*, a quarterly publication, through the International Society for Technology in Education (ISTE). Articles in *SIGTC Connections* contains helpful information and answers to questions such as:

- Who's doing what to organize and communicate with teachers and administrators?
- What committees and techniques work best for other coordinators?
- How can technology coordinators enlist the support of school site administrators?
- How do others disseminate information?
- What are some successful models for providing staff development?
- How should buildings and districts establish and evaluate the use of educational technology in their programs?

SIGTC organizes a NECC workshop for technology coordinators each year and holds its annual business meeting at NECC.

Contact: *Bonnie Marks, Alameda County Office of Education, 313 W. Winton, Hayward, CA 94544*
(510) 670-4162

SCS—The Society for Computer Simulation

SCS is the only technical society devoted primarily to the advancement of simulation and allied technology. It has a worldwide membership and a network of regional councils that covers the United States, Canada, and the United Kingdom.

Simulation is used in every scientific and technical discipline including engineering, manufacturing, biomedical, business, and aerospace. Artificial intelligence, robotics, and CAD/ACM and simulators are areas that have been specifically recognized as important to SCS members.

There are three major SCS conferences each year. They are the SCS Western Multiconference, the SCS Eastern Multiconference, and the Summer Computer Simulation Conference (SCSC).

Contact: *Nancy Roberts, Lesley College, Graduate School of Education, 29 Everett Street*
Cambridge, MA 02138-2790
(617) 349-8419

CAUSE

CAUSE is the association for managing and using information technology in higher education, with a focus on enhancing the administration and delivery of higher education through the effective management and use of information technology. Through its programs and services, CAUSE serves over 2,800 memebers on more than 1,060 college and university campuses around the world.

CAUSE member services include:

1. Professional Development-through the annual conference, seminars, the CAUSE Management Institute, workshops, constituent groups, and recognition programs, including the CAUSE ELITE (Exemplary Leadership and Information Technology Excellence) Award and the CAUSE Award for Excellence in Campus Networking.
2. Publications-including the quarterly CAUSE/EFFECT magazine, several newsleters, the CAUSE Professional Paper Series, and other member publications
3. Information Exchange-through the Exchange Library with more than 2,200 items, including documents contributed by member campuses, CAUSE/EFFECT articles, conference papers, and videos, and the CAUSE Institution Database (ID) Service, a custom reporting service with data about computing environments and strategies on CAUSE member campuses.

Contact: *Michael Zastrocky, CAUSE, 4840 Pearl East Circle, Suite 302E, Boulder, CO 80301*
(303)449-4430

Reviewer Acknowledgements

The National Educatonal Computing Conference thanks the following people for their contribution of knowledge, effort, and time as referees for the papers submitted for presentation.

Eadie Adamson
Robert Aiken
Bill Baird
Bruce Barker
Bruce Barnes
George Bass, Jr.
James D. Beck
Shirley Becnel
Danielle Bernstein
Rick Billstein
Gary Bitter
William Blubaugh
James Bradley
George Brett
David Brittain
Ken Brumbaugh
J. S. Cameron
Doris Carey
Lowell Carmony
Cathy Carney
Lillian Cassel
N. John Castellan, Jr.
Margaret Christensen
Richard Close
Betty Collis
Sheila Cory
Scott Cowdrey
Steve Cunningham
Joyce Currie Little
Nell Dale
Herbert Dershem
Mike Dunlap
Henry Etlinger
Reynolds Ferrante
Larry Flick
Judith Gerstig
Cindy Hanchey
Dale Hanchey
Darylann Hansen
Dennis Harper
Brian Harvey
David Hata
Sandee Hedetniemi
Rachelle Heller
Mark Horney
John Impagliazzo
Betty Jehn
Lawrence Jehn
Dale Johnson
Tony Jongejan
Daniel Joyce
Henry Kepner, Jr.
James Kerlin
Elliot Koffmann
Ann Lathrop
Annabelle Lavier
John Lawson
Erica Lodish
Antonio Lopez, Jr.
Mei-Yan Lu
William F. Lyle
Harold MacDermot
Kim MacGregor
Gary Marchionini
Stephen Marcus
Bonnie Marks
Diane McGrath
John McGregor
Carroll Melnyk
Ted Mims
Bonnie Mohnsen
Ivy Montoya
Mike Mulder
Maggie Niess
Paul Ohme
Trevor Owen
Helen Padgett
Barry Pitsch
Doris Ray
Dick Ricketts
Bob Riser
Nancy Roberts
Wally Roth
Dean Sanders
Robert Seidman
Penelope Semrau
Stephen Sesko
Ted Sjoerdsma
Dennis Spuck
D. Stevenson
Connie Stout
Marguerite Summers
Helen Takacs
Harriet Taylor
John Tenny
Robert A. Thompson
Leslie Thyberg
Joe Turner
Henry M. Walker
David Weinman
James Wiebe
Billy Wood
Terry Wright
Sharon Yoder

Monday

Spotlight Sessions (M1.1).................... *1*
Standards of Excellence: Special Education Best Practice Models
Madaline Pugliese, Bill Davey, and Paula Bloker

The Applied Use of Adaptive Technology for the Multihandicapped
Steven Noll

Multi-focused Uses for Technology by Deaf and Blind Students
Paula Bloker

The Sinkhole Project
John Gagel

Take Control!
Bill Davey

Spotlight Sessions (M1.2).................... *2*
Virtual Realities: From the Concrete to the Barely Imaginable
Stephen Marcus

Spotlight Sessions (M1.3).................... *3*
Writing Proposals for the National Science Foundation
Gerald L. Engel and Forbes Lewis

Spotlight Sessions (M1.4).................... *3*
Videodiscs for Education: The Best and the Rest
Perry Reeves

Society Sessions (M1.5)...................... *4*
The Co-NECT School: From the Known to the Imaginable
Society for Computer Simulation (SCS)

Society Sessions (M1.6)...................... *4*
Exemplary Projects In Telecomputing
International Society for Technology in Education (ISTE)

Paper (M1.7a).................................... *5*
Curricular and Ethical Impacts of Computer Networks in the Classroom
Linda Null, Tim Daniels, and Robert H. Schneider

Paper (M1.7 b).................................... *11*
Human Infrastructures to Enable the Magic of Information Technology
Monica Beltrametti

Paper (M1.7c).................................... *16*
Creating Multi-Year Student Schedules Using Artificial Intelligence
David L. Parker

Paper (M1.7d).................................... *21*
A Management Information System for Effective Schools
Donald N. McIsaac

Projects (M1.8) *24*
(Teacher Training)
A Classroom Instructional Technology Center Can Revolutionize Learning and Teaching
Robert H. Reeve, John W. McBride, Ernesto M. Bernal, Carl L. Hoffmeyer, M. Akraam Rana, and Ron Pontius

Making Multimedia Multiply: A Teacher Training Project with CD-ROM
Denise Shorey, Catherine Williams

Model for Creating a Computer-Using Teacher Education Faculty
Neal Topp, Denise Schmidt, and Ann Thompson

Cooperative Groups: Conjecturing and Technology in the Geometry Classroom
Nancy Zarach, Pat Tinto, and Barbara Shelly

Projects (M1.9) *26*
(Instructional Applications)
An Intelligent Simulation Training System
John Biegel

Authentic Assessment in the Technology-Based Classroom: Using Student Response Journals
Beverley E. Crane

Teachers and Telecommunications: Policy Implications of a National Survey
Margaret Honey and Andres Henriquez

Project Egret: Traveling the World's Electronic Bicycle Paths: Interactive Electronic Learning
Sandra McCourtney and Sally Lucke

Integrating Multimedia Applications into the Curriculum Using IBM Technology
Brian Scarbeau, Becky Thornton, and Glen Ricci

Projects (M1.10) *28*

(Potpourri)

LEGENDS: Using Multimedia to Explore Native Cultures
Gene Bias

Multimedia Director's Primer: Implementation Strategies for the Classroom Teacher
George Blakeslee

Multimedia Lesson Planning with *Electronic Chalkboard*
Vicki E. Hancock

Magic Formula for Motivation: Technology & Real-World Projects
James Scalise

Projects (M1.11) *30*

(Hypermedia)

Clicking Your Way Through Interpersonal Conflict
Eileen Bergeron

A Hypermedia Project: A Native American Cultural Bridge at UC Irvine
Kimberley Burge

Zapping the Hypermedia Zoo: Evaluation in a Constructivist Learning Environment
Vito M. Dipinto and Sandra V. Turner

Interactive Multicultural Counseling: Role Playing Environment
Ronna Olivier, Margery Neely,
Chandima Cumaranatunge, and Seree Weroha

Projects (M1.12) *32*

(Instructional Software)

Using Interactive Mathematics Texts as Teaching Tools
Marcelle Bessman and James E. White

Water Wizards
Sarah A. Finigan

Use of Educational Technology in Engineering Case Studies
Thomas T. Liao

Projects (M1.13) *34*

(Educational Software)

Image Processing for Teaching: A Teacher's Perspective
S. Hardesty, R. Kolvoord, R. Greenberg,
M. Magisos, and R. Strom

The Image Processing for Teaching Project
R. Kolvoord, S. Croft, R. Greenberg, M. Magisos,
and R. Strom

Diversity by Design
Terri Meade and Kathy Powell

Geographical Information Systems for School Administrators
Kenneth Temkin and Paul Cote

Posters (M1.14) *37*

(E-Mail & Instructional Applications)

Using Electronic Mail for Data Collection in Educational Research
Susan Anderson

On-Line Instructional Methodologies for Distance Learning
George Fornshell

The Magic of Electronic Classrooms: Promises and Pitfalls
Genell Harris

Combining Distance Education Technology for Course Delivery
Larry Hudson and Phyllis Olmstead

Radio/Satellite Technology in Education
Greg Jones

Spotlight Sessions (M3.1) *38*

Managing Global Learning Projects: On the Internet and in the Classroom / Drinking From a Firehose: Real Life on the Internet (Part I)
Yvonne Andres and Al Rogers

Spotlight Sessions (M3.2) *38*

Managing Global Learning Projects: On the Internet and in the Classroom / Drinking From a Firehose: Real Life on the Internet (Part II)
Yvonne Andres and Al Rogers

Spotlight Sessions (M3.3) *39*

ACM Model High School Computer Science Curriculum
Susan M. Merritt

Spotlight Sessions (M3.4) *40*

Books With No Pencils...NOT!
Roger Wagner

Society Sessions (M3.5) *41*

How to Build Your Own Local Area Network
Educational Computing at Minority Institutions (ECMI)

Society Sessions (M3.6)......................*41*

Careers in Computing: Toward a Broader, Gender-free Perspective

Special Interest Group on Computer Uses in Education (SIGCUE)

Society Sessions (M3.7)......................*42*

Move Over Whittle, We're Already Doing It: Are For-Profit Schools a Reasonable Alternative?

Society for Computer Simulation (SCS)

Paper (M3.8a)......................................*43*

Computer Simulation of Laboratory Instruments Speeds Learning and Reduces Costs

Robert L. Baxter & William R. Moore

Paper (M3.8b)......................................*47*

Human/Computer Interface Issues in Educational Computing

Anthony Storms Akins

Paper (M3.8c)......................................*52*

The Novice Model in a Modern Algebra Intelligent Tutoring System

Constance M. Conner and Barbara A. LiSanti

Projects (M3.9)...................................*57*

(Teacher Training & Instructional Applications)

Learning About ILSs: What Has Research Shown?

Ken Brumbaugh and James L. Poirot

"Kids" CAMP: Computer Animation Macintosh Project

Chris Carey and Jan Blau

Managing the Mid-Life Crisis: New Directions in Instructional Computing

Sandra Etheridge and Joseph Howell

A Mathematics Computer Lab from Concept to Completion

Paige A. Lado

Projects (M3.10)................................*59*

(Multimedia)

Connecting Students and the Community Through Hypermedia

Larry Adamson and Ty Pelfrey

Communicating in Public: Native American Students Develop Multimedia Museum Displays

Doreen Bailey and Dan Ferguson

Hurricane Andrew: A Kid's Perspective

Beverly Cameron and Helen Blanch

Chemical Conjurings: Student Multimedia Simulations

Vito M. Dipinto and Bonnie Thurber

Projects (M3.11).................................*61*

(Logo & Instructional Applications)

Polygons to Fractals: Logo Work With a Mathematically Gifted Student

Eadie Adamson

Using Logo to Teach Critical Thinking Skills

Ron Place, Mike Sansing, and Chuck Auck

The Middle School: Don't Work Easy, Play Hard!

Marian Rosen

Projects (M3.12).................................*63*

(Teacher Training)

Making Magic in Texas: Telecommunications Assist Universities

Brad Chilton

Mathematics Education and Advanced Technologies: A Collaborative Inservice Model

Neal Grandgenett and Robert Mortenson

EPSS: A New Approach to Staff Training

Pamela Zimpfer and Doris Nabi

Projects (M3.13).................................*65*

(Multimedia & Instructional Applications)

See to Say Multimedia Literature Experiences for Bilingual Children K - 5

Jack Baumann, Sharon Gallivan, and Grace Hom

750,000 Students Under the Sea: Supportive Bilingual Multimedia Science

Ward Cates

Enabling Students Through Hypermedia and Multimedia Creates Magic

Terry Cahill Frost and Barbara Awerkamp

Infusion of Technology into the Curriculum

Carolyn Chambliss, Diane Kornegay, and Debra Bell

Projects (M3.14).................................*67*

(Potpourri)

Evaluating the Academic Impact of Technology in Science

Shirley Becnel

Respect and Recognition: A Staff Development Model

Cathy Hutchins and Roger Coffee

Hi Tech Summer School—Chapter One Students

Kathy Rehfield-Pelles

Posters (M3.15) *69*

(Teacher Training)

Preservice Teacher's Ability to Evaluate CAI: Do Advanced Organizers Help?
Robert Fons

Portfolio Assessment/Technology/Teacher Preparation: Experiment in Progress
Kathy Hammons and Patricia Kalfsbeek

Developing Technology Leadership in School Library Media Specialists
Nancy Todd

Computer Literacy as a Process
Marty Wolf

Spotlight Sessions (M4.1) *70*

The Future of Textbooks: Electronic vs. Print
Sylvia Charp, Mike Eason, Janelle Leonard, and Bill Barnett

Spotlight Sessions (M4.2) *70*

Electronic Assessment
Irwin Kirsch and Jerry Morgan

Spotlight Sessions (M4.3) *71*

It Takes Two to Tango: Hypermedia and Videodiscs
Perry Reeves and Roger Wagner

Spotlight Sessions (M4.4) *71*

Applying Technology Standards in the Accreditation of Teacher Preparation Programs
Joyce Friske, Panel Chair
LaJeane Thomas, Don Knezek, Sally Sloan, Harriet Taylor, and James Wiebe

Society Sessions (M4.5) *72*

Teaching With A Story Generator
Association for Small Computer Users in Education (ASCUE)

Society Sessions (M4.6) *72*

Making REAL Internet Connections: Experiences from the National School Network Testbed
Society for Computer Simulation (SCS)

Society Sessions (M4.7) *73*

Alternative Approaches to Laboratories for Introductory Computer Science
Special Interest Group on Computer Science Education (ACM / SIGCSE)

Paper (M4.8a) *74*

Learning With Computer Software: What Knowledge Actually Transfers?
Robin H. Kay

Paper (M4.8b) *80*

LOGO Research—Forward or Back?
Wing K. Au

Paper (M4.8c) *91*

Virtual Reality: Magic in the Classroom
Mark L. Merickel

Projects (M4.9) *96*

(Telecommunications)

Montana Telecommunications Project (METNet): Distance Education in Big Sky Country
Janis H. Bruwelheide

Kid Link: Telecommunications in a Global Community
Carylie Lawson

Choosing On-Line Solutions for Your School: Which One is Right?
Rachel Pinson

Motivation for Conversation: International Relay Chat (IRC)
Jude Sacry

Projects (M4.10) *98*

(Special Populations & Instructional Applications)

Developing an Ecology Unit for Native Americans
Barbara Brehm

Summer Magic at Computer Camp
Adrianne Hunt and Judy Anderson

Technology Meets Bilingual Education in a Large Southwestern Pueblo
Patricia Jury and Elizabeth Whitaker

Bringing Technology to All Disciplines
Larry McHaney, Margaret Reed, Janice Kelso, Madeline Howard, Greg Gaston, and Aubrey Hillman

Projects (M4.11) *100*

(Restructuring & Instructional Applications)

Lee County's Pilot Technology Schools: The Foundation for Long-Term Planning
David Kreller, Tim Osborne, Mike Jones, and Cyndy Loomis

The Magic Continues
Bronwyn Rhoades, David Smith, and Larry Martin

Local School Technology Leadership: The Key to Success
Bard Williams and George Bagwell

Technology Peer Assistants: Empowering Students
Mary S. Haverfield and Sherah Carr

Projects (M4.12) *102*
(Educational Software)
Bilingual Software/CDs Ensure Equal Opportunities in Elementary Classrooms
Chencho Flores and Angela Mielke

Technology Building Blocks For Literacy
Laurie Rosenthal and John Black

Using Technology to Enhance the Teaching of Writing at the Secondary School
Harriet Scarborough and Allen Swanson

Technology-Assisted Language Learning (Project TALL) for ESOL Students in Grades K-12
Joanne Urrutia and Michael Eason

Projects (M4.13) *104*
(Teacher Training)
Hypermedia Use in a Constructivist Approach to Introductory Earth Science
Patricia A. McClurg, James McClurg, J.R. Boyd, and Andy Bryson

Distance Education: The Application of Technology to Education and Training
Al P. Mizell and Lois Ann Hesser

Computer Technology For Elementary and Middle School Students at USC-Aiken
Gary J. Senn

Building a Virtual Community of Teacher Researchers
Patricia Tinto, Barbara Shelly, and Nancy Zarach

Projects (M4.14) *106*
(Teacher Training)
Technology Integrated With Models of Teaching
Phyllis Hotchkiss and Michael Land

The Roving Workstation Project: A Model for Improving Teacher Education Faculty Use of Technology
Julie A. Poage and Dorie Munson

Technology in Florida's Teacher Education Programs: Investigating the Issues
M. D. Roblyer and Ann Barron

Discovering the Magic of Multimedia
Maria Swayne, Maria Tavares, and Karen Hare

Posters (M4.15) *108*
(Research)
Distinctiveness of Icons in the Graphical User Interface
Larry Johnson

Information Needs in Medium Size School Districts
Noreen Michaud

Integrating Different Formats of Research Results on Distance Education in Pakistan
Hiroo Saga

Cognitive and Motivational Change of an Autistic Child through Using the Computer
Chiyoko Terayama

Tuesday

Spotlight Sessions (T1.1) *109*
Here Come the Robots: An Educational Robotics Update
Tom Lough, Panel Chair

Spotlight Sessions (T1.2) *109*
The Disney Partnership: Parents, Kids, and Teachers
Brian Napak

Spotlight Sessions (T1.3) *110*
Florida Schoolyear 2000: Restructuring Schools on a Technology Base
Owen Gaede, Wendy Cullar, Peggy Kinder, Marty Beech. and Pam Zimpfer

Spotlight Sessions (T1.4) *111*
The School Administrator as a Technological Leader
Chase Crawford, Martha Rahming, and Henry Pollock

Spotlight Sessions (T1.5) *111*
Musical Applications of Educational Computers
Fred Hofstetter

Society Sessions (T1.6) *112*
Teaching and Learning with Technology in the Classroom
Special Interest Group on University and College Computer Services (ACM / SIGUCCS)

Paper (T1.7a) *113*
A Computer Based Presentation of an Introductory Programming Course
John A. Cicero and John Groppe

Paper (T1.7b) *116*
The Digital World: Teaching Technological Literacy to a Multidisciplinary Audience
Barry Fagin

Paper (T1.7c) *122*
Preliminary Evaluation of IDG Technology for Distance Education in Alaska
Peter J. Knoke

Paper (T1.8a) *130*
Technological Advances Reflected in a Current Elementary Instructional Reading Approach
Mary Coesfeld Huneke

Paper (T1.8b) *134*
Forming High School and University Alliances: Magical Things Can Happen
Carol W. Wilson

Paper (T1.8c) *137*
What Makes Teachers Use Computers?
Edward Vockell, Helen Jancich, and Jackie Sweeney

Paper (T1.9a) *138*
Microcomputer-Based Laboratories for Non-Majors' Physics Courses
Doug Davis, Steven W Daniels, Charles E. Miller and Rachelle Bergmann

Paper (T1.9b) *140*
Image Processing on a Personal Computer
Richard Johnsonbaugh , Steve Jost, and Dicran Goulian III

Paper (T1.9c) *144*
Computers-in-Education in Malaysia: The Way Ahead
Zoraini Wati Abas

Projects (T1.10) *149*
(Teacher Training)
Educational Technology: A Significant Field Experience Component
Jacqueline Dillon

Training Teachers to Effectively Integrate Technology into Their Instructional Programs
Herbert Rieth, Matt Ebeling, and others

LaserNet: Dissemination and Implementation within a School
Barbara Shelly, Suzanne Gilmour, and Marilyn Trainor

The Development and Implementation of an Instructional Computing Program for Preservice Teachers
Ann Thompson, Denise Schmidt, and Neal Topp

Projects (T1.11) *151*
(Restructuring)
Educational Technology Research and Development: The Texas Challenge
Ken Brumbaugh and Paul Resta

Adapting Computer Based Instruction to Learning Styles of LD Children
Cathrine Byrd

Teachers Swap Textbooks For Multimedia
Fayette Clarke

Data Collection and Portfolio Development in a Restructured Curriculum
Chip Kimball

Technology: A Natural Bridge Between School and Community
Bronwyn Rhoades, David Smith, and Larry Martin

Projects (T1.12) *154*
(Telecommunications)
Internet for the Middle-Level Student—A World Without Doors
Scott Dixon

Case Studies of K-12 Educators Use of the Internet
Margaret Honey, Andres Henriquez, and Katie McMillan

Using On-Line Resources in Designing Instruction
Douglas Hyde and Julie Furst-Bowe

Computers, Amateur Radio & Carl Hayden High School
Alejandro Reyes and Allan Cameron

Projects (T1.13) *156*
(Logo)
An Inclusion Project Using Computers: Summer Fun in the City
Eileen Boyle Young

Children's Experiences in a New Logo-Based Construction Environment
Sharnee Chait

Problem-Solving with LogoWriter: The Magic of Math with Machines
Kathleen Maury

LARC Logo Teachers Shaping Their Classrooms: Logo Action Research Collaborative
Donna Rosenberg and Patricia Rowe

Projects (T1.14) *158*
(Teacher Training)
Design and Training for the Classroom of the Future
Jacqueline Janik

The ABC's of Designing a Media Production Facility for Education Majors
Judy Lee

Distance Teacher Education: Delivery of Graduate Instruction
Lois Ann Hesser and Al P. Mizell

Projects (T1.15) *160*
(Telecommunications)
Project LA-Konnect: An Interactive Telecommunications Simulation Model
Sheryl Abshire, Donna Mancuso, and Diane Manson

Learning Spreadsheets Using Stock Quotes from Prodigy
Sharon Andelora

A Case Study in Telecommunications in Education: The Holocaust Project
Shirley Hanein

Posters (T1.16) *162*
(Global Education)
Global Classrooms: The Air Project
Rhonda Christensen, Gerald Knezek, Nola Campbell, and David Moore

Environmental Awareness and the Use of ECOWIJS
Ries Kock and Mark Goedkoop

Global Education: A Family Affair
Raymond Fehr

Spotlight Sessions (T3.1) *163*
Computer Training and Support: Lessons From Industry
Eliot Masie

Spotlight Sessions (T3.2) *163*
Freedom and Justice...For All?
Carol Edwards, Jo Sanders, and Rita Oates

Spotlight Sessions (T3.3) *164*
Integrating Telecommunications and Curriculum: Successful Experiences from Learning Network Mentors
Margaret Riel, Panel Chair

Spotlight Sessions (T3.4) *165*
Illumination: It's Elementary!
Fred D'Ignazio

Society Sessions (T3.5) *166*
Using Models and Simulations for Learning
Society for Computer Simulation (SCS)

Society Session (T3.6) *166*
Methods for Teaching & Understanding of Computing for High School Teachers: Part I
Ez Nahouraii, Panel Chair

Society Sessions (T3.7) *167*

A Bill of Rights and Responsibilities for Electronic Learners
EDUCOM

Paper (T3.8a) *168*

Computer Conferencing: A Course on Computers and Society
Alfred Bork

Paper (T3.8b) *171*

The Adoption and Diffusion of an Electronic Network for Educators
Julie A. Hamilton and Ann Thompson

Paper (T3.8c) *175*

Raising Consciousness Through Telecommunication
Indu Varma and P.K. Varma

Paper (T3.9a) *180*

Information Searching Behaviors and Attitudes
Shu-Hsien Chen

Paper (T3.9b) *185*

New Approaches to Learning Geometry by Using GeoBlock
Kazuyoshi Hidaka and Satoru Yoshimura

Paper (T3.9c) *194*

Evaluation of Writing Instruction Using Computers
Neal Schleifer

Projects (T3.10) *202*
(Software Applications)

Attracting Students With Magnets
Thomas A. Akin, Steve Muise, Mike Lopotka, and Robert D. Williams

Looking for the Fairy Godmother to Make the Magic Work
John Dufour

Image Processing in Secondary School Space Science
Patricia A. McClurg

Building Support for the NBA (No Boys Allowed) Multimedia Team
Mary Van Dyke

Projects (T3.11) *204*
(Multimedia)

MultiMedia Made Easy!
Forest Barbieri

EcoGuide: An Interdisciplinary, Multimedia Approach to Environmental Education
Elizabeth Carlson

Computer Literacy for the 90s: A Multienvironment Multimedia Event!
Susan A. Garrett and Dolores Pusins

IBM Computer Camp for Kids
Julie Wallace

Projects (T3.12) *206*
(Networking / Telecommunications)

Presentation Magic—A Local Area Network Teaching Laboratory
Robert N. Cook

Networking: Is It Worth It?
Larry J. McHaney

Implementing the Internet in the Elementary Classroom
Randy Sachter

Projects (T3.13) *208*
(Special Populations)

A Library Computer Lab With Curriculum and Teacher-Productivity Software
Dorris Collmorgen and Mary Goodwin

Chapter 1 Computerized: By All Means!
Jean Reynolds and Charles T. Gardner

The Computer Clubhouse: A New Model for Afterschool Centers
Natalie Rusk

***Consumer Reports* in Computer Applications Class**
Donna L. Spatz

Projects (T3.14) *210*
(Software Applications)

Celebrating the Magic of Technology in the Writing Classroom
Karla Burkholder

Home Grown Primary Language Arts Labs
Mathew M. Maurer, Lynn Noel, and David Spencer

Critical Thinking with Technology: Insight from Action Research
Judi Repman

Posters (T3.15)......................................212
(Technology in the Curriculum)
INTEGRATE the Magic of Technology: PUBLISH an Elementary School Newspaper
Estelle Bentzen

Elementary Students Producing Magazines Using Aldus PageMaker
Kathleen Huggard-McKinney

Getting Started: Making the Multimedia Leap
Annette Lamb

Multimedia and the Development of Literary Understanding: A Survey of Existing Applications
Carla Meskill and Karen Swan

Video Manipulatives for Mathematics
Margo Nanny

Spotlight Sessions (T4.1).....................213
Instructional Technology in NASDC Proposals
Henry Olds

Spotlight Sessions (T4.2).....................213
Creating Mother-Tongue Literacy With The Computer: Make It Happen In Your Classroom
Bill Peet and Libby Peet

Society Sessions (T4.3)........................214
Methods for Teaching & Understanding of Computing for High School Teachers: Part II
Institute of Electrical and Electronic Engineers (IEEE)

Society Sessions (T4.4)........................215
Supporting New Ways of Teaching and Learning With Technology-Enhanced Classrooms
ISTE Special Interest Group for Technology Coordinators (ISTE / SIGTC)

Society Sessions (T4.5)........................215
Restructuring Science Through Technology
ISTE Special Interest Group for Technology Coordinators (ISTE / SIGTC)

Paper (T4.6a)..216
Using Student Experience to Guide Curriculum in Introductory Computing
Gerald E. Gau and Sandra Madison

Paper (T4.6b)..222
Classroom Equipment for Instructional Enhancement of a Computer/Math Core Course
Chaya Gurwitz and Neomi Halpern

Paper (T4.6c)..226
Developing a Computer Architecture Course: Lessons Learned
Linda H. Rosenberg

Projects (T4.7)......................................230
(Computer Science)
Teaching Programming Logic Using Computer Controlled Robots
Bob Coil and Ed Harper

QBasic Programming—Creative, Challenging, Cheap
Theresa Cuprak and Jill Jones

E.S.C.A.P.E.—Expert System Computer Aided Programming Educator
Joyce Morrison and W. Eugene Simmons

Projects (T4.8)......................................232
(Hypermedia)
Interpretations of Whole Number Operations: Multimedia in K-4 Mathematics
Mary Jane Ford, Anne Fontaine, and Carol Scott Whelan

Molecules, Mammals, Learning Styles—Creative Use of Computers through HyperCard
Kathleen Haviland and Edward Sweetman

Whole Language + Technology = Magic
Patricia S. Horn

Collaborative Learning with Hypermedia-Based Instruction
Judi Repman, Herman Weller, and William Lan

Projects (T4.9)......................................234
(Practical Issues)
Faculty Computer Use in a College of Education and Allied Professions
Gregg Brownell, Ron Russell, Nancy Brownell, and Dieter Zirkler

Geographical Information Systems for School Administrators
Paul Cote and Kenneth Temkin

Computerized Adaptive Testing: Realizing New Relationships with Assessment
Arthur Doyle

A Boys Network: Melton Fellows Global Networt
Mei-Yau Shih

Projects (T4.10) *236*

(Multimedia)

The CAISYS Project: An Interactive Videodisc Solution for Information Dissemination
Randall Coorough, Randall Stovall, and Edmund Gross

Food for Speech: "Can We Eat Now?"
Debra Freedman

Instruction With Digitized Video: Putting the Focus on Instruction
Michael Land and Phyllis Hotchkiss

Building Interactive Language Simulations: Crossing the Border Without Leaving Home
Marianne Phinney, April Koch, and Jaime Nuñez-Cruz

Projects (T4.11) *238*

(Multimedia)

Multimedia Portfolios: Stories and Presentations
Sandra Becker and Leroy Tuscher

Research and Writing in High School: The Electronic Alternative
Ann Bleakley

Project Einstein: Integrating Multimedia Into The Curriculum
Nancy Elnor and David Hehman

Interactive Laserdisc Anesthesia Simulation for Veterinary Technology Students
Guy Hancock

Projects (T4.12) *240*

(Telecommunication)

Telecommunications and "Society's Problems: Links Between Prisons and Classrooms"
Bill Burrall and Jay Vickers

The Middle-Level Student Becomes A Global Scientist
Scott Dixon

The Integration of Telecommunications Into Special Education Student Teaching
Wenfan Yan, Julie A. Poage, and Dorie Munson

Posters (T4.13)..................................... *242*

(Technology in the Curriculum)

Telecommunications and Social Studies: Two Successful Projects
Gerald Crisci

Algebra Motivation by Computer Assisted Instruction
Cheryl Feser and Alex Reyes

"Set on Freedom:" History, Hypermedia and Criss-Crossed Conceptual Domains
Karen Swan and Marco Mitrani

Using Spread Sheets/Graphing To Teach a Variety of Science Lessons
William Sumrall and Gene Aronin

Wednesday

Spotlight Sessions (W1.1)....................243

NSF Funding Opportunities for Undergraduate Computer Science
Doris Lidtke

Society Sessions (W1.2)......................244

Ethics Curricula—Issues and Suggestions: A Panel Discussion
Consortium for Computing in Small Colleges (CCSC)

Society Sessions (W1.3)......................244

New Knowledge Networking Contest
International Society for Technology in Education (ISTE)

Paper (W1.4a)......................................246

Preparing the Next Millennium's Leaders: Advocating Technologically Competent Elementary Principals
John F. Beaver

Paper (W1.4b)......................................252

Promoting a Broader Perspective on Computers in Careers
Valerie A. Clarke and G. Joy Teague

Paper (W1.4c)......................................255

Labs, Learning Styles, and Gender
Cindy Meyer Hanchey

Projects (W1.5)....................................259

(Multimedia)

Multimedia Science for Students With Special Needs
Blanca Aguilar

Educational Electronic Networks and Hypertext: A Message Assistant for Distributed Learning Environments
James A. Levin and Michael Jacobson

Students Dedicated To Learning Through Music and Technology
Fred Polansky

SMART Kids: Developing Teacher Resources
J. Fred Schouten

Projects (W1.6)....................................261

(Teacher Training)

Large Scale District Training– A Train the Trainer Approach
Candy Egbert and Robert Dycus

Teaching Desktop Publishing: A Collaborative Approach
Julie Furst-Bowe

Using Interactive Videodisc Technology for Elementary Teacher Training
Carol Scott Whelan, Mary Jane Ford, and Anne Fontaine

Teacher Education: Retooling With Technology
R. Michael Smith

Projects (W1.7)....................................263

(Instructional Software)

The Magic of Parental Involvement with Technology
Tammy Havens, Roxanne Greco Butler, and Vanessa Cunningham

The Computer As A Learning Integrator: Toolbox for Lifelong Learning
Stan Silverman and Gene Silverman

Welcome, Aliens! Promoting Earth to Out-of-this-World Tourists
Lottie J. Simms

Projects (W1.8)....................................265

(Computer Science)

Get the "H.O.T.S."! Cooperative Learning Methods in Computer Science Classes
Jill Jones and Theresa Cuprak

The Computer Selection Game
Carl Stafford

The "New" Computer Literacy
Sharon Yoder

Projects (W1.9)....................................267

(Telecommunication)

Effective Curriculum Integration of the Global Student Telecommunications Work: The I*EARN Experience
Edwin Gragert and Peter Copen

Complimentary Video and Data Networks
Beth Lowd

Projects (W1.10) *268*
(Practical Issues)
Developing a College General Education Requirement Promoting Computer Literacy
William Boles, Jim Carraway, and Donald Hall

Designing Classes For Teachers New To Technology
Georgia Brousseau and Virginia Griffis

HELP! CPU For The Computer Phobic
Debra Freedman

Development and Design of Interactive In-Service Training for Rural Social Workers
Sabrina Su-Fen Chin, Cia Verschelden, Kevin M. Kramer, Bebbie Folse, Linda Thurston, and Janice Denning

Projects (W1.11a) *270*
(Curriculum Integration)
The Computer as a Teaching Tool in Secondary Mathematics
Doug Brumbaugh

Using the Mathematics Exploration Toolkit in the Secondary Mathematics Classroom
Charles E. Lamb

The Pride of Publication: Teachers Make Their Own Books
Elizabeth Anne Viau

Will the Nintendo Generation Read Books on a Computer Screen?
Jeri Wilson

Projects (W1.12) *272*
(Educational Software)
WINCORP: The Wickliffe Interactive Network for Computers on Real Problems: An Innovative Cross Curriculum
Richard Benz, Alex Bezjak, Chris Capaso, Pat Coil, and Judith Palermo

Writing, Content, Computers Converge: The Alaska Writing Project
Heidi Imhof

Old-Fashioned Print and Newfangled Technology: Whole Language for the '90s
Peggy Healy Stearns

Inquiry-Based Learning Environment Provided by Database
Jho-Ju Tu

Projects (W1.13) *274*
(Restructuring)
Restructuring Education in New York State
Peter Flyzik, Richard Steinfeldt, and Harry Tuttle

When the Magic Has Faded... What Next?
Jeff Holte and Shirley Kratochuil

Choosing Success—Florida's Co-Development Project for Students at Risk (Grades 9-12)
Ann Kinstler, Mike Eason, and Cheryl Weiner

Professional Development for Tomorrow - Creating Magic through Technology and Restructuring
Sue Misiak, Jane Hoover, Betsy Sidovenko, and Sheila Cantlebary

Spotlight Session (W3.1) *276*
Networking in the Nineties: An EduQuest View
Kathy Murray and Linda Randall

Society Sessions (W3.2) *277*
Object Oriented Programming: What High School Teachers Need To Know
International Society for Technology in Education (ISTE)

Society Sessions (W3.3) *277*
Building Treehouses for Learning: Thematic Technology Tools For Kids
Association for Educational Communications and Technology (AECT)

Society Sessions (W3.4) *278*
Integration of Technology Into Field Experiences of Preservice Teachers
ISTE / SIGTE

Society Sessions (W3.5) *279*
Notebook Computers: Features and Options for Educators
Special Interest Group on Computer Uses in Education

Paper (W3.6a) *280*
Electronic Mail Simulations: Powerful Training Tools
Mike Eason, Ann E. Barron, and Karen Ivers

Paper (W3.6b) *284*
Computer Networking: A New Tool for Student and Teacher Education
Margaret Riel

Paper (W3.6c) *288*
Mediation in Network-based Learning Activities: Successful Technical and Content Strategies
Clinton E. Stapleton

Paper (W3.7a)......................................*291*
RHINO: Creating Learning Experiences, an Overview
Miriam J. Salman Masullo

Paper (W3.7b)......................................*295*
Computer Assisted Video Instruction Of A Classical Indian Dance Form
Mythili Sridhar and James Levin

Paper (W3.7c)......................................*301*
Student-Produced Hypermedia as an Empowering Tool
Roger Volker

Projects (W3.8)....................................*305*
(Instructional Software)
Integrating Educational Technology and Elementary Mathematics Curriculum
Betty Bjork, Dan Dick, and Kim Benson

Infortissimo: Music With The Computer
Paul Jansen

It's A Small World - Project Make A Difference
Donna Rosenberg

Linking Technology with Thematic Unit on Endangered Species
Shelley B. Wepner and Nancy E. Seminoff

Projects (W3.9)....................................*307*
(Restructuring)
Implementing New Technologies: Collaborative Research in a Middle School Setting
Leslee Francis, Ted Riecken and Pierce Farragher

Improving Student Performance Through Technology
Darylann Hansen

Transforming the K-12 School: The Summit Experience
Ken Uckotter

Projects (W3.10)..................................*309*
(Multimedia)
Quick Curriculum Connections With QuickTime
Sheryl Abshire, Diane Manson, and Barry Humphfus

Florida's "Tech Team" Helps Schools Improve Through Technology
Lynn Cullum, Jack Edwards, Steve Newhouse, Pete Lenkway, Susan Schmid, and Donna Riley

Designing Issues for Development of Constructivist Hypermedia: The Wetlands Project
Diane McGrath, Hilary McLellan, and Mark Viner

Windows on Science In The Elementary Classroom
Raymond Fehr

Creating Multimedia Magic in the Classroom
Linda M. White

Projects (W3.11a)................................*312*
(Multimedia)
The Teacher's Partner: Developing Multimedia for the Foreign Language Classroom
Stacie Hibino, Lynda Milne, Edna Coffin, and Jerome Johnston

de-
The Magical ^ Mystery Tour
Tina Petrone, Edward Kelberg, and Sam Williams

The Art Students' Portfolio For The Multimedia Age
Anne Powers

One Macintosh, Thirty Students, Drill and Practice, NOT!
Karen Thompson and Donna Holinga

Civic Education Hypertext Project: From Curriculum Framework to Classroom Implementation
Charles S. White, Erika Berner, and Dean Nelson

Projects (W3.12)..................................*315*
(Multimedia)
Technology and Multimedia in the Restructured Primary School
Cheryl Basham and Rosaland Henderson

The Magic of Literature: Reading and Laser Discs
Peggy Remis and Jeanette Scheibal

Put A Star In Your Classroom
Ivy Montoya

Using Quick Time To Help Preserve Native Languages
Richard Sgarlotti and Bruce Hanninen

Teacher Training—Interactive
Michael Speziale, Christina Charnitsky, Michael Garzella, and Lynne LaFrance

Projects (W3.13a)................................*318*
(Instructional Software)
Social Studies Teaching About Religion Through Technology
Beth Gordon

Notebook Computers and the Implications for Education
Chip Kimball

Summer Computer Camp: A Place To Encourage Girls in Technology
Edith Kort

Projects (W3.14) *320*

(Emerging Technologies)

Project Egret: Electronic Paradigms—E-Mail and "Live" Satellite Application in Education and Industry
Sally Lucke, Sandra McCourtney, and Zsuzsanna Ardo

"Let's Go Technology", Planning A Successful Program
Terry Gonzales, Grace Hom, and Michele Parga

Cost Effective Networking In The School Office
Anthony Sassi

Project IDEALS: Computer Network Simulation Around the World
David Crookall

Monday

Spotlight Sessions (M1.1)

Standards of Excellence: Special Education Best Practice Models

Madaline Pugliese and Bill Davey
Adaptive Rehabilitation Technologies, Inc.
Marblehead, MA

Paula Bloker
Arizona School for the Deaf and Blind
Tucson, AZ

Abstract

Four model programs have been designed to serve students with a wide range of disabilities, and were awarded education grants from Apple Computer, Inc. Guidelines specify that projects would: create an interdisciplinary approach; give students greater control over their educational experience; serve economically disadvantaged students, including targeting the inclusion of special needs students; develop creative and effective uses of technology; and develop links between classroom learning and learning outside of school. Now mature projects, the coordinators discuss creating their models and designing program adaptations, while assessing the changing needs of their target populations. The panel discusses innovative, interdisciplinary technology-based curriculums proven successful and replicable and the efficacy or impact resulting from these dynamic projects. Please note: Even though the panel of applicants are grantees via Apple's education grants program, this session will inform participants of these model programs in special education practice and is a non-commercial venture.

The Applied Use of Adaptive Technology for the Multihandicapped

Steven Noll
Sindey Lanier School
Gainesville, FL

Abstract

The use of computers can provide new pathways to all phases of the curriculum for students with educational disabilities. Students can use adaptive devices to allow for individualized access which takes advantage of student cognitive and sensory-motor strengths. This project collaborates with a local university's Department of Special Education as part of their teacher training programs. The direct application of assistive technology directly benefits both the students in their classrooms and the University students as they prepare to apply their coursework.

Multi-focused Uses for Technology by Deaf and Blind Students

Paula Bloker
Arizona School for the Deaf and the Blind
Tucson, AZ

Abstract

This project has helped the ASDB restructure, not just by adapting the technology to conform to preconceived notions as to what the technology MIGHT do for such students, but discovering new ways of learning using appropriate technology tools. Program includes: HyperCard stacks on Native Americans of Arizona, Braille translations of student assignments, and adaptive access from a range of perspectives. Goals for the project also include examination of employment issues for such students.

The Sinkhole Project

John Gagel
Woodbridge Academy
Lexington, KY

Abstract

The project studies the effects of sinkhole pollution and resultant ground water contamination in Kentucky. Goals for the LD students include: develop and reinforce linguistic, logical thinking and problem solving skills, and foster communication, social skills and community awareness. The integrated, interdisciplinary curriculum focuses on the student as an active participant in the learning environment and the use of technology as a multimedium for exploration, learning, expression and synthesis of information.

Take Control!

Bill Davey
Adaptive Rehabilitation Technologies
Marblehead, MA

Abstract

ART provides computer awareness training for the generally disabled public through a series of adaptive technology fairs called **Take Control!** These fairs are held in various locations throughout the US, and they offer disabled consumers and their families an opportunity to work with expert teachers and examine ways that computer technology can enable their lives.

Spotlight Sessions (M1.2)

Virtual Realities: From the Concrete to the Barely Imaginable

Stephen Marcus
University of California, Santa Barbara
Santa Barbara, CA

Abstract

This presentation deals with deep media. It illustrates unusual (some would say offbeat) interfaces and metaphors for future educational computing. These include systems like Reality Built for Two, Virtualities, Mandala, the Alternate Reality Kit, the Virtual Environment Workstation, the Rubik Cube, SemNet, and A Very Nervous System. The discussion includes attention to new Japanese software initiatives, the development of the smart book, and the elusive RUM, DWIM, and DWIN commands.

The central concept involves "virtual realities," simulations that you seem to enter physically. If text "*tells*, and video and film *show*, then a virtual reality *embodies*" the world it creates (Randall Walser, Autodesk Research Lab). This leads to considerations of how to represent things that are essentially indiscernible (Warren Robinett, University of North Carolina).

This presentation illustrates virtual reality hardware and software and explores the educational implications of radical shifts in point of view: you can *become* the data, and you can function in environments in which space itself is the interface.

Our involvement with new technologies generally moves from an ambivalent relationship with augmented abilities to the "dawning of irreversible change" (Akram Midani, Carnegie-Mellon University). This presentation suggests some of the implications of virtual realities—for various subject matter areas, in adaptive technology, and on our expectations and visions for educational computing.

Spotlight Sessions (M1.3)

Writing Proposals for the National Science Foundation
Gerald L. Engel and Forbes Lewis
National Science Foundation
Washington, DC

Abstract

This session will concentrate on a number of aspects of the NSF grant process. It will include presentations of currently available programs, a discussion of trends, and a review of process and procedures. Particular reference will be made to programs of the Computer and Information Science and Engineering (CISE) Directorate. Some discussion will also involve the items normally expected by the NSF program officers. Time will be made available for individual discussions and questions.

Spotlight Sessions (M1.4)

Videodiscs for Education: The Best and the Rest
Perry Reeves
Pioneer New Media
Carson, CA

Abstract

Abstract not available at press time

Society Sessions (M1.5)

The Co-NECT School: From the Known to the Imaginable
Society for Computer Simulation (SCS)
Henry F. Olds, Jr., Panel Chair
Bolt, Bernak and Newman, Inc.
Boston, MA

Abstract

The Co-NECT School, a design for a new American school developed by the Educational Technologies Department of Bolt Beranek and Newman, Inc., is one of eleven winning designs chosen by the New American Schools Development Corporation. The Co-NECT school design transforms the context of learning by restructuring the school community, creating a project-based curriculum, applying new assessment procedures based on a personal growth system, and establishing a new technological infrastructure based on an open communications network. In the Co-NECT design, computers are completely ubiquitous and pervade all aspects of the lives of teachers, students, and, hopefully, parents. All these changes have their roots in research projects conducted at BBN, as well as at other institutions, and they lead to a radically transformed educational program for the future.

Panelists:

Ruben Canter and John Richards
Bolt Beranek and Newman, Inc.
Boston, MA

Society Sessions (M1.6)

Exemplary Projects In Telecomputing
International Society for Technology in Education (ISTE)
Lynne Schrum, ISTE (SIG/TEL) Panel Chair
Center for Teacher Education
Plattsburgh, NY

Abstract

This session will present projects using telecommunications to enhance the learning of students within a variety of content areas, grades, and locations. These projects will be presented by the winners of SIG/TEL's Third Annual Telecomputing Activity Contest. Presenters will offer suggestions for replicating the projects and interact informally with the audience.

This abstract was taken from the author's originally submitted proposal

Paper (M1.7a)
Curricular and Ethical Impacts of Computer Networks in the Classroom

Linda Null, Tim Daniels and Robert H. Schneider
Northwest Missouri State University
Maryville, Missouri

Introduction

Computers are becoming an integral part in today's society, and the amount of information available via networks today is astounding. Corporations, universities, and high schools are starting to incorporate computer networks as a necessary means of accessing the wealth of information obtainable. The ability to network is part of the reason computers are gaining popularity and acceptance, and this information technology is having a definite impact on higher education. Networks (such as the Internet) can be used as educational tools to increase computer literacy, provide leading-edge research, improve social awareness, increase enthusiasm toward learning, provide social and academic interaction and develop ethical consciousness. At the same time networks can serve to make today's students tomorrow's leaders in technology.

A major tool available today is the Internet, a publicly accessible international computer network. Sufficient working knowledge and proper utilization of the network provides students with the information and experience necessary to survive and compete in the evolving information age. Use of the network introduces them to concepts they might not see otherwise. For example, continued use of the Internet allows students to become more familiar with computer terminology, operating system concepts and basic hardware notions. The network also allows access to many different types of teaching aides including such things as electronic books and information, on-line libraries and public bulletin boards. Teachers from across the country can exchange lesson plans, tests, teaching units and varying philosophies on a wide variety of subjects via electronic mail. There are also many on-line information services provided for teachers.

One of the most significant contributions of traveling around the world via networks is the ability for users to visit people and locations without actually being there—the ability to bring a world of people and information within reach. Students can interact with experts in a given field, international counterparts and others using the network in pursuit of knowledge. This interaction can be used to exchange ideas, introduce new concepts, ask questions and help those in need of advice. Public access to user bulletin boards provides a means for enthusiasts in various areas to discuss, debate and disseminate information. This ability to learn from afar is no doubt having a significant impact on our students now, and it will continue to do so in the future.

Networking not only contributes to student learning but also provides the teacher with a new educational medium. Because networks are easily accessible, many teachers are already using local, regional and national networks on a constant basis. Networks can help the teacher bring back the students' enthusiasm for learning by adding a new educational medium to the classroom that can be integrated into the total curriculum. For example, interdisciplinary assignments involving the Internet and various information gathering techniques (for such things as world news and weather data) are only two of the ways nation-wide networks can be used in the classroom. Networks can be used as a resource tool, helping students to discover new and exciting areas of exploration and investigation.

Along with ready access to the Internet comes the social responsibility to act ethically and morally. As access increases, so does the opportunity for unethical practices. Teachers must be cognizant of these problems and must also make their students aware of them. The ethical issues that must be addressed include plagiarism, software piracy, information theft, harassment, abuse of resources, illegal access, and problems associated with viruses and worms. This paper examines these ethical issues and also presents an overview of the integration of networks into the classroom.

A Brief Introduction to the Internet

In the late 1960's, the Internet, created by the Pentagon's Advanced Research Projects Agency, went on-line. NSFnet, the National Science Foundation network, makes up the backbone of the Internet. There are regional networks that tie into this backbone with quite informal local links to the network. Since its introduction, the Internet has grown to allow access to more than 5000 networks in 100 countries by well over 4 million users [1]. But still its existence is not as well known as many researchers and educators feel it should be. Few people outside the computing world realize what it is or who uses it. In fact, it was not until 1988 when Robert Morris, Jr. infected the net with his famous "worm" program that a large majority of people began to understand the magnitude of Internet.

The Internet consists of several diverse networks with no central control. The Internet Society is a non-profit international organization consisting partially of the Internet Architecture Board (IAB), the Internet Engineering Task Force (IETF) and the Internet Research Task Force (IRTF). This society raises money which is used to publicize the information available via the Internet. The 10-15% monthly growth rate in computer hosts on the Internet combined with the 25% monthly increase in traffic over the net indicates successful publicity.

Technically, all information transmitted over the Internet should be related to research and education. Generally, applications over the net fall into four categories: anonymous ftp (file transfer protocol), E-mail (electronic mail), telnet (remote log-in), and news (Usenet news groups). By using anonymous ftp, updated lists of most anonymous ftp sites can be retrieved (i.e., connecting to ocf.berkeley.edu and retrieving the file ftpsite). Once retrieved, this file provides information about publicly accessible ftp sites. Several sites dedicate large amounts of storage to maintain archive files of source code, games and other information. An anonymous ftp to wuarchive.wustl.edu will provide the user access to archived files.

There is no directory of Internet users, so sending E-mail can often be difficult. A file called /pub/usenet/comp.mail.misc located at pit-manager.mit.edu explains various methods of locating people on the Internet. A WHOIS database is run by the Network Information Center (NIC) and allows users to issue the 'whois' command to search for registered users. Normal users can register with this database by filling out a form from the NIC available via anonymous ftp (ftp to nic.ddn.mil and retrieve the file 'netinfo/user-template.txt'). The form can then be E-mailed to registrar@nic.ddn.mil, resulting in the user's name being added to this database.

Various applications can be run on remote computers using telnet, a program which creates connections with remote machines. The file Infoguide.XXXXX.txt located at ftp.sura.net in the /pubs/nic directory contains an excellent explanation of various systems. Available also via anonymous ftp from csd4.csd.uwm.edu is the file /pub/inet.services.txt which contains a list of services offered by the Internet. The MaasInfo package contains an overview of how to use services available over the Internet [4].

The Internet newsgroups (Usenet News) are provided by a set of machines exchanging articles from various groups including government agencies, large and small universities, high schools, businesses and even personal computer owners. Newsreader software, such as nn or rn, is required to transport and read Usenet articles. Many places allow guest logins to read these groups (i.e., telnet to bbs.oit.unc.edu and log in as bbs).

Perhaps a greater challenge than learning how to access various pieces of information via the Internet is how to locate and download the files that you want. The information available over the Internet could easily fill a book with such things as applications software, services, archives, bulletin boards, electronic books and various indices. (See [2,3]). People desiring software can check with Archie, a central database of information about Internet-accessible archive sites, plus server programs that provide access by telnet, ftp and E-mail. This database maintains a list of over 1000 archive sites containing software, documents and data representing over one million files. A user can search based on string matching, site lists, site contents and software descriptions. Microcomputer users are especially attracted to this as these software archives also include DOS, Amiga and Macintosh programs. Accessing Archie simply requires a telnet session to an Archie site (such as archie.rutgers.edu) and logging is as archie. A help command can assist a beginning user in finding any desired files. Archie not only organizes Internet offerings for anonymous ftp sites, but also provides access to the whatis description database, which gives the name and a short synopsis of thousands of public domain software packages on the Internet.

Many other services are available on the net. The Internet Relay Chat (IRC) system is a real-time system that allows people to discuss current topics. People from all over the world can join in to make comments and ask questions. There are various channels, each devoted to different current topics, such as a "hurricane" channel or a "Gulf war" channel. The On-Line Book Initiative (OBI) is a publicly accessible repository for books, conference proceedings and various other reference materials that can be shared. Although some information has been stored electronically, efforts are continuing to get all information into electronic form. (Further information is available via E-mail to obi@world.std.com or by phoning 617/739-0202.) Project Gutenberg focuses on English language electronic texts, with a goal of 10,000 of the most used books to be on-line by the year 2001. (More information can be obtained by sending E-mail to hart@vmd.cso.uiuc.edu).

Educational Applications

The network has much to offer everyone. The applications for education on the elementary, high school, and college levels are numerous. Professionals and businesses can also use the Internet for research. Whether it be educational or commercial, the Internet has the potential to increase the amount of information flow and to provide access to a variety of interesting things.

Teachers today are incorporating technology effectively into the classroom to help prepare the students for using this technology in the "real world" when they graduate. The Internet can help with this process by allowing students to access many varied services. They can research topics by accessing libraries across the world. Although many accesses of this type are to library holdings only (catalogs, etc.), once a book or periodical is located that can help the student, interlibrary loan can be used to obtain the necessary information. Some libraries on the Internet now allow access to electronic books (telneting to wugate.wustl.edu with the username services allows transfer of some of these electronic books via E-mail). By a simple file transfer (via ftp or E-mail), a student can easily obtain the necessary information. For example all the libraries in the Colorado education system have pooled their inventories onto an Internet accessible site. Students can check all their resources with one query, and then they will be told where the books are located and given the call numbers needed to obtain them. Another example is the Research Libraries Information Network which is an on-line bibliographic database with well over 40 million records including records of special collections, maps, sounds recordings, and even photographs. The number of library catalogs accessible via the Internet increases daily. Included in this list are several in the United States, Germany, Mexico, New Zealand, Australia, Israel, Switzerland, Sweden, the United Kingdom and others. A MS-DOS hypertext database of Internet resources is available from wuarchive.wustl.edu via anonymous ftp.

Library catalogs are among the most popular of the Internet services. Students can also use the Internet to exchange ideas for research, talk with professionals, and even converse with family and friends by using E-mail services which allow these students to send messages and certain types of files over the lines to each other. Feedback comes quicker and is therefore more helpful to the students as well as the educators. K-12 user news groups have increased in numbers, allowing students of all ages to discuss a vast majority of topics with others from around the world. Our students can now travel to the rain forests of Africa or the mountains of India without ever leaving home. Cultural exchanges at this level can have a significant positive impact on our elementary and secondary students by giving the student a wider window to the world. International cooperative efforts can result in such things as role playing simulations and other real-time applications. Students from far-reaching areas can combine efforts to do such things as rewriting the Constitution (role playing the various characters), writing poetry and short stories, simulating environmental decisions (such as building dams or cutting down forests), studying a foreign language and interacting with travelers who respond to questions regarding social, psychological, cultural and environmental concerns.

Students can now obtain vast amounts of information more quickly and with greater ease than ever before. This tends to create excitement and eagerness for learning among the students and instills in them a desire to learn more and more, increasing not just their computer literacy but also their literacy in many other fields. With this new found knowledge they can prepare for the problems of tomorrow, and hopefully, will be able to cope with them more easily. Internet is becoming an indispensable tool to help stimulate young minds to learn.

FrEdMail (Free Educational Mail) Network is a teacher/student exchange network to allow teachers to share teaching materials, curriculum ideas, classroom experiences, motivational techniques, workshop material, information on educational legislation and job opportunities. A mail message can be sent to help@cerf.net containing a request for more information on FrEdMail.

Teachers can also use the Internet to show students certain basic computer skills that they may require to get along in a computerized society which extends well past the borders of the students' states and countries to include a good portion of the world. With this new found ability, the students' horizons are broadened and the power to learn is increased. The Internet not only helps teachers to teach about computers, but it also allows teachers to learn many things themselves that they otherwise would not. Teaching is a time consuming task, and any tool that will reduce the time required to learn is greatly appreciated—the Internet is such a tool. Teachers can exchange ideas with other teachers in the same field, specialty or area. This exchange is simplified drastically with the E-mail service of Internet. Teachers can also locate and obtain many different kinds of teachers' aids and educational materials which are stored in different areas accessible through the Internet. For instance, the National Aeronautics and Space Administration Spacelink service has a listing of all the education materials available and the cost of these materials.

Via this new technology, teachers and students have the ability to communicate with their peers. One must also keep in mind that this communication also goes on between students at one institution with faculty from another institution. Being able to talk to faculty in a certain fields allows students to discuss ideas with many different educators. Teachers can talk with colleagues to find out changes and exciting breakthroughs not yet published. Questions regarding technical papers can be sent directly to the author, and responses are quick and personalized.

Companies and educational institutions are allowing employees or students to interact with users at other companies or schools for ideas. Many research groups use electronic mail and ftp to work together, even though they are physically separated by thousands of miles. This allows a combination of resources rather than just the resources that are available in any one area. Many companies even allow access to their computers during closed hours. By allowing this joint processing, larger and more complex simulations for research purposes can be accomplished.

Because of the practical educational applications and the potential for learning, many professionals are pushing the United States government into establishing the NREN, the National Research and Education Network [2]. The first step in this direction was taken when the National Science Foundation gave a grant to establish the NSFnet which now links 16 supercomputing centers in the U.S. The President's Office of Science and Technology, which felt the U.S. was lagging in high-technology, issued its Federal High Performance Computing and Communications Program report to propose research in four areas: high performance computing systems, advanced software technology and algorithms, basic research and human services, and a national research and education network. This last category has received the most attention, as NREN will have approximately one thousand times the present capacity of existing networks. Although many proponents agree on the necessity, many disagree on who should pay which costs and who will manage the NREN. The proponents feel that this network could be established with the use of the Internet instead of requiring another completely independent network to be established. This network, when functional, will allow researchers to interact and help in research efforts conducted worldwide.

The Internet made its mark on education from the beginning and will continue to do so at an increasingly higher pace. The physical distance between researchers is becoming less of a hindrance as resources become more readily available to different people. The ease with which Internet can be used has contributed significantly to its success. Internet's full impact on society cannot and will not be fully measured for a long time, but one can get a sense of its enormity from just the millions of people who use it.

Ethical Issues

As we can see, there is a great deal of interest being ignited in the areas of computer education and research. However, as with any emerging technology and rapidly changing environment, this technological advance is also stimulating behaviors that can cause ethical dilemmas and creating legal challenges. Time is being dedicated to teaching people how to use computer networks and to making sure that they have access to them, but little time is being spent teaching ethics and establishing the basic laws of usage.

In a typical university setting, an estimated five percent of computer literacy class time deals with ethics. This is analogous to spending one hour teaching someone how to drink but only one minute teaching them how to behave responsibly while drinking. Although many high schools have basic programming courses, they tend to ignore issues of computer ethics. Rebellious teens often become involved with hacking, cracking and software piracy. Those students wishing to form friendships find it inexpensive and easy to offer their new-found friends pirated software. Students who naturally have low finances will band together to trade software in order to keep their costs down. Many students realize that this is going on and begin to think that there is nothing wrong with software piracy.

On a college level (and at some secondary schools) we see students rapidly gaining access to computers and networks. These students have had little experience with the negative consequences of technology and its abuse. Many first time users find how easy it is to talk with multiple people over E-mail. In many schools, there is a direct correlation to grades and the amount of E-mail activity a student participates in. There are also games available over networks as well as bulletin board systems and chat utilities which many students use. Although these aren't necessarily bad, many students tie up networks for these purposes, keeping others who wish to use the systems for academic pursuits from accessing the network effectively.

Abuse of resources is probably one of the most common ways people misuse today's technology. Basically, abuse of resources involves using computer resources in manners in which they where not intended, generally for nonacademic and personal reasons. E-mail is often one of the most abused of all resources. Nearly everyone on a large computer network gets an account which can be used to transfer messages between groups of people in a variety of methods. Networks often have large amounts of time tied up by people taking part in E-mail activities not related to academic or work purposes. Compu-Sex (a form of computer mailing closely related to the theory of Phone Sex where individuals engage in written sexual activity) is very common, accounting for a large percentage of the abuse. Another form of E-mail abuse involves chain-letters, which are essentially electronic extensions of their original counterparts. Playing games also consumes time on many systems, when others need to use the resources.

Abuse of resources occasionally extends to the point where laws become broken. Harassment takes place on many bulletin boards and via E-mail. Computer networks such as Internet allow a wider area in which the harassment can take place. They also allow for easier formation of electronic hate groups, an unfortunate by-product of easy access to international networking. Computer-aided cheating is also a new phenomenon where easily accessible information allows students to plagiarize with less chance of getting caught, trade information about tests, and in very extreme cases manipulate their own grades. Information is also becoming more accessible on how to commit crimes (such as dismantling pay phones, making bombs and breaking and entering). Pornography is also something easily found on many networks today. Many do not allow these materials or, if they do, they will screen the ages of the users, but often children slip through and systems miss files. Although these materials are not necessarily illegal, there are many children accessing the Internet who are not of the proper age to acquire these materials.

Although many abuses and misuses of the nationwide network are simply offensive, some have become criminal acts. One reason why breaking laws via computer networks is so large spread is the low preparation time, the low risk factor and the immediate and sometimes large-scale payoff. Viruses and worms are very popular for this reason. Take for instance the Michelangelo virus. A virus is a relatively simple program requiring little time to write (a worm is much like a virus except it is limited to one system or series of systems). The Michelangelo virus was released and caused a nationwide panic. The author received national (if not international) recognition and has (at the time of this writing) not been caught. Because computer networks are becoming so accessible and wide-spread, computers from several corporations and countries are accessible to the common student and in many cases the common person. This allows amazing access to a large variety of information, some of which is private and easily stolen by simply entering the proper set of commands. This private information can be used for personal use, or even sold to the highest bidder.

Theft of private information is not the only problem emerging in our technologically advanced society. Students have easy access to resources which make plagiarism much more tempting and undetectable. With the abundance of information available via the Internet, it is considerably more difficult for teachers to detect when plagiarism has occurred simply because there is no realistic way to check sources. Some unethical network users even provide services dealing with pre-written papers for students. All a student has to do is find the proper source and a paper on any topic can be obtained in a matter of minutes. There is no effective way to monitor this type of transaction, although some computing centers limit ftp and telnet privileges in hopes of deterring this type of abuse.

Computing center directors are now forced to deal with an entirely new set of problems—those created by easy access to networks. Directors attending the SIGUCCS 19th Annual Computing Services Management Symposium completed a survey on the frequency of breaches of acceptable computer behavior with the following results: [6]

Incident	Percentage
User "hacked" into a university computer	43
Virus infected a university-owned workstation	91
User received E-mail that s/he considered harassing	71
User received E-mail that s/he considered obscene	65
Someone used a computer account without authorization	78
User shared his/her password inappropriately	87
User illegally copied university owned software	70
User illegally copied privately owned software	51
Chain letter E-mail circulated on campus network	33
User complained that content of BBS was obscene	29
User complained that content of BBS was harassing	25
User took advantage of system, software/security flaw	54

Networks allow such easy access that directors now not only have to worry about locals "hacking" into the system, but also have to be concerned with remote users attempting the same thing. Anonymous ftp offers a tremendous amount of software, which creates yet another concern. Many people do not perform a virus check first, resulting in possibly infected systems in schools and on campuses. Harassing and obscene messages via E-mail have become a definite problem. Cultural differences can result in a seemingly innocent E-mail being regarded as offensive. Although electronically offending someone from a different cultural background is often done by mistake, it is too often done on purpose. Even though the purpose of the Internet is research and other academic pursuits, many of the bulletin board services offer a wide range of information, from jokes and recipes, to truly offensive and tasteless stories and suggestions.

There are many other problems afflicting world-wide computer networks. Different countries have unfamiliar cultures which lead to different laws and ethics; what is legal in one country may not be in the next. Students need to understand that abusing the Internet is not something to boast about. There is the myth that those who break into government and private computer systems can get jobs on those systems, because their ability to hack into the system impresses the management. Vandalism on systems, lack of respect for operating times, and lack of proper operating knowledge on behalf of the user are issues that need to be addressed.

The solutions to these problems are not easy nor are they simple. Before others may be taught computer ethics, teachers in large must embrace them. The problem with taking up a code of ethics in regards to computer systems is that there is not really an adhered-to code in existence. It is difficult to found a cross-cultural code of ethics, since different countries have different ideas of what is right and wrong. However, networks can have rules applied to all those who use them, and although enforcing these rules can be difficult, this could result in a significant improvement. Federal laws now exist in their infancy in the United States, but once again many networks like the Internet cross national boundaries. Education about computing ethics, therefore, must begin in our schools. Then, and only then, can we expect students to start understanding the implications and ethical issues associated with international networks.

Conclusion

The future possibilities of Internet in education are impressive, and as more information becomes available, students will be exposed to different subjects at a younger age. Student involvement will become more personalized as students will be independently pursuing subjects of interest. Teachers must provide an educational environment that encourages students to question "facts" and seek challenges. That environment must also create an ethical awareness; too many people feel it is the duty of the computer center to prevent people from using their wares in antisocial ways. Most certainly the interaction available on the net will promote better understanding of social and political issues. As more and more information becomes available (much of it in conflict), students must be taught to critically assess the value and validity of this information. Grace Hopper once said "We have to learn to manage information and its flow. If we don't, it will all end up in turbulence."

Computer networking provides numerous educational opportunities. We should use these opportunities to teach students to think about ethical and social norms, to develop community standards and understand how these standards affect them, to participate in information gathering, information management and decision making and to understand the impact of technology on their lives. We can begin this process in our elementary schools by using computer networks to expose young children to many unfamiliar situations and peoples they would not ordinarily encounter. One thing is certain: this information revolution is changing our lives, and we must prepare our students to cope with its promise and potential.

References

Lynch, Daniel C. and Marshall T. Rose, *Internet System Handbook, Addison Wesley,* 1993.

Krol, Ed. The Whole Internet User's Guide and Catalog, O'Reilly & Associates; Inc., 1992.

Fisher, Sharon. "Whither NREN", BYTE, July, 1992, pp. 181-189.

Stager, Susan F. "Computer Ethics Violations: More Questions than Answers", EDUCOM Review, July/Aug 1992, pp. 27-30.

For the Internet Resource Guide and a list of Internet service providers: NSF Network Service Center (NNSC), BBN Systems & Technologies (Cambridge, MA) or anonymous ftp to nnsc@nnsc.nsf.net and retrieve the file /resource-guide.

For the MaasInfo Package containing an overview of how to use services available over the Internet, anonymous ftp to aarnet.edu.au, subdirectory pub/doc, all files beginning with "Maas."

Paper (M1.7 b)

Human Infrastructures to Enable the Magic of Information Technology

Monica Beltrametti
University of Alberta
Edmonton, Alberta, Canada

Abstract

Information technology is regarded by many universities as a magical tool for increasing institutional productivity. However, in today's distributed computing environment, human infrastructures are as important as technological ones in reaping the benefits of information technology as a productivity tool.

In this paper, we describe the cross-departmental functions that have to be performed to ensure wise application of information technology. We then describe some of the human infrastructures being developed at the University of Alberta in an attempt to ensure that information technology delivers the appropriate returns on investments.

More Magic Expected of IT

The role of information technology in higher education has shifted in recent years. In the past, information technology was primarily viewed as a tool to add value to institutional activities. Value was added, for example, by the introduction of central computers to perform intensive numerical computations, which enriched academic activities by opening up new fields of research. Similarly, electronic manipulation of institutional data allowed colleges and universities to offer better support services to students and faculty.

Recently, however, an increasing number of people are asking whether the value added by information technology to research, education, and administration is proportional to the costs incurred in purchasing it. That this question is being asked in a period of shrinking budgets is not surprising and, consequently, institutions expect information technology to increase institutional productivity. There is an expectation that information technology not only enrich institutional activities, but also reduce costs, and attempts are being made to measure productivity gains through the use of information technology with a simple formula (i.e., productivity = value added/cost). Clearly, today we are expecting more magic from information technology than in the past. One is tempted to ask whether it will be able to live up to these expectations.

Information technology should be regarded as a means to enhance the productivity of higher education's primary functions: teaching/learning, research, and community services. Administrative activities in higher education are in support of these primary functions.

Several factors will determine the extent to which information technology enhances productivity. Progress in technology will certainly have a large impact. As tools become more functional, results will be obtained faster. Computing literacy is also increasing; more people will be able to make efficient use of technology. It is expected that information technology will become an integral part of many of our activities.

Success of information technology as a productivity tool, will, however, depend heavily on the wisdom with which we apply it. Information technology is only a means to an end—the end has to be clearly understood before information technology can either add value or reduce costs.

The time will probably come when technology is so advanced that it will give us feedback on whether we are applying it wisely; but as of today, institutions (and individuals working within them) are responsible for the wise application of information technology. This wisdom has to be provided by human infrastructures, performing activities aimed at:

- understanding how technology is applied and to what end
- sharing expertise and resources
- exploiting economies of scale

The last two tasks are particularly important in a distributed computing environment. Many of these activities extend across traditional organizational boundaries, demanding management of an extended enterprise.

Planning Activities

Activities to enable information technology to enhance productivity can be divided into two categories: planning, and technology management.

Planning for Higher Education Leads the Way

To apply information technology wisely, an effort must be made to understand the direction of higher education in the coming decades. Higher education will have to undergo substantial changes to educate more people and to educate them better than before in a time of declining budgets. The curriculum, organizational structures, and administrative processes in higher education will no doubt change radically in the future (distance education is an example of things to come).

Universities are today inextricably linked to social and economic processes transpiring locally and globally. Faculties can no longer plan for the future of higher education in isolation. Ongoing planning processes need to be established and plans must be formulated with the participation of all relevant stakeholders: industry, government, students, and taxpayers. Higher education directions need to be constantly revisited. From the point of view of tying in technology with planning for the evolution of higher education, there is a need for the all-round participation of information technology staff, so as to allow timely adjustments of technology plans to higher education directions. Only then will we have the opportunity to apply information technology wisely.

Technology Directions

Planning new directions for higher education is an ongoing process but planning for information technology cannot stand still. While there are risks connected with implementing technology plans without first understanding completely the directions of higher education—it is likely that some investments will be wasted—there is no real alternative but to press ahead. The risk is worth taking since inaction or ad hoc activities would probably lead to even greater unnecessary expenditures.

There are various reasons why technology planning at both the institutional and departmental levels is more important today than ever.

- Distributed computing has made technology management more complex. Conflicting roles have to be resolved. For instance, the role of end-users in technology planning and management has increased as they have the autonomy to purchase equipment and develop applications. On the other hand, in order to capitalize on the distributed computing investment, institutions have to apply economies of scale when purchasing or using equipment, a proper role for the central information technology organization. As well, sharing of resources and expertise require collaboration between end-users and the central organization.

- Technology plans can no longer be formulated in isolation by a central organization. Planning has to be done in collaboration with users. Plans that require a large institutional commitment have to incorporate support from senior administrators. These planning efforts require collaboration across traditional organizational boundaries.

- A common frame of reference for the development of information technology is provided by a technology plan. Even though technology directions cannot be imposed, planners can give guidelines to the campus on equipment to purchase which ensures easier support, interoperability and thus better return on investments.
- We have seen an acceleration in technological evolution in recent years and we must anticipate where technology is heading. This can only be achieved through careful understanding and analysis of the market.
- With shrinking budgets, financial plans become essential. Financial plans for information technology organizations have to be based on a technology plan.

Effectiveness of Institutional Processes

There is a great temptation to try to enhance efficiency of activities through the application of information technology without first reviewing whether the activities themselves are effective, or even necessary. Imagine, for example, an institution wanting to make the management of forms more efficient by implementing electronic forms and authorization methods. Upon inspection, the institution would probably find that many forms used are based on obsolete and convoluted administrative processes. Before expending funds in the computerization of forms, the institution ought to first review the processes and make them more effective. Only then will an information technology innovation produce overall productivity gains. Or, imagine an electronic student registration process that does not relate the number of students enrolling with class availability (the author knows of an institution where this is the case!). At registration time, students will bring the system down by repeatedly trying to get into the few available classes. The institution will not solve the students' problem by augmenting the computational power devoted to the registration process unless the footwork to make the process effective has been done in advance.

There is a need to set up planning activities crossing departmental boundaries that enable ongoing reviews of such processes. Involvement of information technology staff in this review process is essential.

Technology Management

Role of Central Computing Organizations

In the past, central organizations were responsible for the implementation of technology solutions whereas today they are more involved in creating infrastructures within which users can implement their own solutions. Central computing organizations have to work closely with end-users to make this happen.

For example, a data communications backbone network is a campus-wide infrastructure which is best managed by a central organization. Management of distributed LANs, however, is best done by the departments concerned, as application of information technology at this level must be tailored to a department's specific needs. Of course, collaboration with the users is necessary to ensure appropriate connections between the backbone and the LANs and between end users and the wider world of networking.

In a similar way, management of institutional data should be shared with the users. Based on user input, a central organization can take leadership in establishing standards for storing and accessing data and in providing users with tools that make for easy manipulation of data. The users can then access and use the data at their convenience without having to rely on a central organization for data processing. Ensuring the security of institutional data and its integrity are, however, in the rightful domain of a central organization.

Economies of Scale

Applying economies of scale to information technology enhances productivity substantially throughout the whole institution.

Sharing Expertise

Computer literacy is common today. Many departments are hiring their own computer support staff and computing expertise is spread all over the campus. To capitalize on this human investment, sharing of expertise is important. Facilitating communication among computer experts throughout the campus and creating communication vehicles helps dissemination of knowledge. A central computing organization can provide the infrastructure for this to happen.

Sharing Resources

Computing resources are spread all over the campus as well. There are tools today that make sharing of some of these resources possible. For example, the combination of a high-speed campus backbone network and implementations of distributed computing paradigms such as PVM (Parallel Virtual Machine[1]) allow the sharing of "workstation farms" among users at various locations around the university.

The tools alone, however, are not enough to make sharing of workstations happen: an environment has to be created in which users seek collaboration, offer their workstations to the farm, and agree to adhere to some rules of usage. A central computer organization can provide the leadership to establish such an environment.

Coordinating Purchases of Computer Equipment

Users often negotiate their own purchase and maintenance contracts with equipment vendors. Campuses that coordinate vendor relations, establish site licence agreements, and purchase equipment in bulk, can benefit from substantial cost reductions. In order to do this, coordination with users is necessary; a central computing organization is best positioned to do this.

Human Infrastructures

Examples have been given of functions extending beyond traditional organizational boundaries which enhance information technology as a productivity tool. Some of these functions are best driven by central computing organizations, some by users and departments, and others do not fall under the mandate of computing at all. We have seen, for example, that review of administrative processes throughout the institution is necessary, and best driven by senior university administrators.

To make good decisions today, many units must manage an extended enterprise. For computing organizations, the real challenge is not simply to create the technological infrastructures, but to establish human infrastructures to ensure that technology is applied wisely. At the University of Alberta, Computing and Network Services (CNS) has started to manage an extended enterprise. Some of the human infrastructures we have established are described below.

Planning Groups

Two planning groups have been established to help us formulate and periodically review our strategic plan, Networking Computers and People on Campus and Beyond, published in February 1992. One planning group consisting of the University president and vice-presidents helped us formulate our mission statement and high-level goals. The second planning group, consisting of representatives from faculty and administrative units, helped us formulate strategies.[2] We expect to review the strategies yearly with this group.

We have also created a group to help us formulate plans for the manipulation of institutional data. The project is too big for us to handle alone, so the planning group includes representatives from faculties, departments, various administrative units as well as students. The plan we have formulated with this group calls for senior administration to set up inter-departmental task forces to review administrative processes.

To ensure that our planning activities result in a unified and coherent whole, a CNS internal planning group has been set up to formulate an overall technology plan. Setting directions for various fields of technology, such as the future of mainframes, electronic mail strategies, distributed printing, and so on, the technology plan is distributed to the campus a chapter at a time after extensive review by advisory committees (described below). The internal planning group includes CNS representatives with expertise in different fields of information technology.

The University of Alberta is currently formulating a strategic plan for the University. CNS has been asked to comment on preliminary documentation produced by a strategic planning task force composed of University staff and members of the Board of Governors. We hope to become more involved in this process.

Advisory Groups

Advisory groups are being created for networking, instructional computing, research computing, information systems, and technology standards. The groups include representatives from the university community and are advisory to the Vice-President (Student and Academic Services), Dr. Lois Stanford, to whom CNS reports. CNS uses the groups to present plans in the relevant fields of technology, to help CNS promote new directions to the campus, and to help collect and disseminate knowledge throughout the university. For example, we are collaborating with the networking advisory group to train the computing support staff of faculties and administrative units on how to connect departmental LANs to the campus-wide FDDI backbone network.

Service Representatives

We have had requests, especially from the research community, to help users with the day-to-day management of and future planning for their computing equipment. Some CNS staff have therefore been given the duties of a service representative and are assigned to individual departments to help with these tasks.

Service representatives have the goal of understanding the current and future computing and networking needs of their designated client departments. They are encouraged to perform regular walk-abouts to collect and resolve issues, and to help departments with their computing plans. Service representatives participate in all computing-related meetings in their assigned department; they may establish lines of communication with other departments if there is a need to resolve common problems. Service representatives also describe departments' use of computing in written portfolios which are published regularly in the CNS Dispatch newsletter, providing an opportunity for departments to learn from each other. So far, we have started a pilot service representative project covering five departments. We will extend the project once we are comfortable that value is being added to our clients' computing and networking activities.

User Interest Groups

Users in different departments often share a common interest in a specific area, e.g., a type of workstation, graphics, or statistical analysis. User interest groups help such people to interact and fruitfully collaborate. We intend to assign a CNS facilitator to each user interest group, with the assignment to monitor user interests, problems, and requirements. We are currently developing electronic mailing lists for each user interest group, so that interaction among users can occur more frequently.

For the IBM RS/6000 interest group, we have assigned not only a facilitator, but also a CNS system analyst to look after the workstations. The CNS system analyst helps users manage their equipment and helps set up communication links between users in different departments. He also provides a liaison between the users and the vendor. Favorable contracts with the vendor have been negotiated for the users using economy of scale concepts. We intend to extend this service to other user interest groups.

Extended Help Desk

To harness the computer expertise available on campus, the CNS help desk has started a project to create and manage an extended help desk. Computer support personnel in faculties and administrative units have been invited to collaborate in providing help desk functions to the campus. The project will involve training, development of common documentation, an organized approach to problem resolutions, and keeping the campus appraised of computing and networking issues.

Computing Environments

We are in the process of creating other inter-departmental computing environments. For example, we want to use two of the 24 strands of the FDDI fibre optic backbone to connect researchers' computers to a farm of advanced workstations we are building using PVM. Currently, the University of Alberta has 750 advanced workstations on campus. To make this happen, agreement among researchers to adhere to some common administrative guidelines is essential.

Extended Enterprise is Incomplete

We have only started to create an extended enterprise for computing and networking. Many human infrastructures are still missing. For example, inter-departmental task forces aimed at reviewing administrative processes have not been set up yet. Senior university administration is, however, very supportive of the idea and we are confident that this is going to happen soon.

Measuring the Magic

It is difficult to measure the productivity gains resulting from information technology, but we will attempt some measurements soon at the University of Alberta. In our strategic plan, Networking Computers and People on Campus and Beyond, CNS has identified objectives, short-term indicators of success in moving toward the high-level goals of the plan. These objectives are formulated in terms of numbers, such as percentages and increases; or, in terms of perceptions gathered through opinion surveys or evaluations. Here is an example from our plan of a high-level goal and its objectives:

Services

Goal

To provide a range of services, by December 1994, which meet the needs of our clients so that they can have a competitive edge over those at or from other organizations.

Objectives

- Measure on a yearly basis the change in the number of new services offered, and the number of out-dated services deleted.
- Increase the number of services that are highly-rated in the annual survey and increase the overall rating we achieve on all services.

- Measure user perception on a yearly basis to determine how well CNS services enable our clients to excel in being competitive with their peers.

---

[1] PVM is public domain software developed by Dongarra and Geist at Oak Ridge National Laboratory and the University of Tennessee. A number of similar commercial products are also available.

[2] A description of the planning process was published in the proceedings of CAUSE '92 (Dec. 1 - 4, 1992), in the paper "Computing Services Planning, Downsizing, and Re-organization at the University of Alberta."

Paper (M1.7c)

Creating Multi-Year Student Schedules Using Artificial Intelligence

David L. Parker
Salisbury State University
Salisbury, Maryland

Abstract

Curricula with multiple prerequisites (and often with prerequisites to the prerequisites) make planning multi-year schedules for students a difficult task. When we include departmental two-year and/or three-year plans for offering many courses, planning student schedules becomes a nightmare. Long-range student schedules are constantly in need of revision when students change their plans, when departments revise their offerings, or when requirements change. Faculty (and other) advisors, guided by their own experience, usually help students plan one semester in advance, trying to satisfy as many requirements as possible, in the hope that everything will work out by the student's last semester. Important requirements are often missed or are not taken early enough in the student's academic career, and exceptions have to be made in order to allow the student to graduate.

The AI software to be demonstrated at this conference, and described in more detail in this paper, neatly corrects these problems. No matter how complicated the student's situation, and no matter what the student's major, this software will determine all possible ways, if any, to schedule a student to complete requirements. It also provides the student and advisor with "good" schedules for planning.

The source code, written in a version of Prolog, and executable code for IBM PC-compatible microcomputers are available upon request.

Introduction

Nearly everyone who has served as a student's advisor has been forced to create a semester-by-semester list of courses for the student—a list which, if followed, would allow the student to satisfy graduation requirements. In some disciplines this is a routine exercise and requires little more than tabulating sufficient courses of particular types so that requirements are met. However, in highly-structured curricula (such as mathematics, physics, nursing, business, engineering, etc.), there are two main complications: 1) many courses have multiple prerequisites (which themselves have more prerequisites), and 2) many upper-division required courses are not offered every semester but are scheduled to be offered only during specific semesters. (Anecdotal comments from colleagues at other institutions persuade me that offering courses once-a-year or once-every-two-years is becoming something of a norm, particularly since we are all in fiscally lean times.) These and other complications, which I will detail later in this paper, make schedule-planning an intricate, difficult, nearly impossible task in such curricula.

To help illustrate this problem, I have enclosed a partial list of requirements for the Mathematics Major with a Computer Science Concentration from my own institution in Figure 1. After examining the requirements shown in Figure 1, we consider the following question: If a student is taking MATH 201 and COSC 120 in the 1993 spring semester (and has taken no other courses shown), what is the best collection of semester schedules for the student if she hopes to complete all of the requirements on Figure 1 by the end of the 1995 spring semester? Assuming she can do it, what options does she have?

One answer is, of course: 1993 fall semester take MATH 202, PHYS 221, and MATH 210; 1994 spring semester take MATH 310, COSC 220, and COSC 250; 1994 fall semester take MATH 413, COSC 350; COSC 303, and MATH 306; and 1995 spring semester take MATH 414; COSC 450, and MATH 311. The student's few long-range scheduling options will likely be eliminated once additional graduation requirements are included.

In fact this is just the tip of the scheduling/advising iceberg. The Mathematics major offers three other options (besides Computer Science), and each student may choose, with certain limitations, either the "old" requirements for each option or the "revised" requirements in the latest University Catalog. Moreover, because of curricular revisions, some of the courses listed in earlier catalogs no longer exist, and approved substitutes for them must be chosen. Some courses have pre- or co-requisites. Many of the requirements, as in Figure 1, represent a choice from between two courses or from among as many as eight courses. A few courses require students to be in their third or fourth years. Faculty leave or take sabbaticals and do not teach scheduled courses. Finally, with a majority of the upper-level courses offered only once each year or once every two years, planning a student's academic career becomes an herculean task!

Additionally, as every advisor knows, no student stays on the original plan, anyway. So new plans are made each semester, taking into account the student's successes, failures, new interests, personal choices, etc. Even though a department has a two-year plan for offering courses, faculty are constantly (and properly) tampering with the curriculum, and it is likely that a perfectly adequate student plan will be destroyed when a single course is offered, for example, in the 1994 spring semester rather than in the 1994 fall semester. Each student's plan must be reviewed—and likely revised—each semester.

This scheduling problem is reminiscent of the "classic" scheduling problem in Artificial Intelligence, described nicely in Bratko (pp. 293-298) and in Malpas (pp. 194-197 and pp. 293-298). The standard problem concerns an exercise such as constructing an office building. Certain tasks (such as pouring the foundation) must be done before others, but there is some flexibility in terms of the scheduling of other tasks (such as electrical wiring, plumbing, or painting). Depending upon the imposed constraints, we might try find a schedule which would minimize the total construction time, or, if we are keeping track of various expenses, we could schedule to minimize the total construction cost.

The academic scheduling problem is similar, but there are important differences. For example, we have both a student-specific number of work periods (semesters) and a variable number of tasks (courses) to be scheduled in each one. Additionally we have both student-specific constraints as well as variable systemic constraints (two-year schedule of classes, prerequisites, etc.). Finally, rather than scheduling to minimize total time or cost, we are generally scheduling to spread the total number of courses evenly throughout all of the student's semesters.

The Program and Main Algorithm

Prolog utilizes lists as its fundamental data type, so this scheduling problem can be stated something like this: Using an appropriate database, find all possible schedules which would allow the student to complete requirements. Each such schedule should be a list of semesters, with a list of courses for each semester, with the requirements distributed relatively evenly through the semesters. Display and/or print as many of these schedules, in a convenient format, as is desired.

The "appropriate database" is rather elaborate, containing at least 1) a list of requirements for each curriculum option, 2) an interactively-updated list of courses which the student has taken or is taking, 3) a list of courses showing when each will be offered, and 4) a list of prerequisites for every possible course. Fortunately Prolog allows these lists to be written in fairly readable form (although specific dialects of Prolog will deviate slightly from the examples shown here). For example, the requirements in the Mathematics Major with an Option in Computer Science, largely shown in Figure 1, can be stated in Prolog as follows: "required('Math Major, Option in Computer Science', [(math,201), (math,202), (math,306), (math,210), (math,310), (math,311), (cosc,250), (cosc,220), (cosc,350), (cosc,450), (math,413), (math,414), (cosc,303), (phys,X)]) :- X = 121 or X = 221." If the student has taken MATH 201 (a 4-credit course), then we would have "taken(math,201,4)." in the database. MATH 306 is a three-credit courses offered every fall, and that is written: "offered(math,306,'Linear Algebra',3,fall,_)." MATH 414, a three-credit course, is offered in the spring of each odd-numbered year, and that appears as: "offered(math,414,'Mathematical Statistics II',3,spring,X) :- X mod 2 = 1." If a course has any prerequisites, then they are listed, for example (see Figure 1): "prereq(cosc,303,[(math,202),(cosc,120),(phys,X)]) :- X = 121 or X = 221."

The program prepares a list of semesters during which the student will be in attendance and a list of required courses for the curriculum which the student has chosen. Courses already taken (or being taken) by the student are removed from the latter list. The program then moves through the list of remaining required courses, scheduling each one in the earliest possible semester. When it succeeds, the program displays the resulting list of semesters and courses. Subsequent lists are produced by backtracking.

The main algorithm is that which schedules the courses. As the algorithm removes each course from the list, it checks to see if the course has already been scheduled. If so the algorithm moves on to the next course in the list. If the course needs to be scheduled, the algorithm finds the first semester in the list that 1) does not already have too many courses scheduled, 2) is a semester in which the student will be a junior or senior (if that is a requirement), 3) is a semester when the course will be offered, 4) has all of the course's prerequisites scheduled in preceding semesters, and 5) has all of the course's corequisites scheduled in the same semester. If the algorithm cannot fit the course into the schedule, the program backtracks to the last course scheduled and places it in another semester. If necessary, the algorithm backtracks again (and again, etc.). Once it puts the course into a semester, the algorithm returns to the list of required courses to schedule the next course in the same manner.

Prolog has automatic backtracking and is totally recursive, so this code will find solutions, if they exist. Strategies for improving the Prolog code in scheduling are discussed in Rowe, Chapter 13. Sterling and Shapiro also suggest numerous ways to improve the Prolog code. The main optimization which I found useful is noted below under "Effectiveness of the Program."

The Prolog code for the main algorithm appears in Figure 2. "Semester" is the number of the semester under consideration. "Maxsemester" is the highest-numbered semester which the student can use. "Maxhours" is the maximum number of required hours allowed to be scheduled in any semester. "sem_num" simply provides information about the semester from the database. "check_standing" verifies that the student is a junior or senior (if that is required). "check_prereq" and

```
schedule([(Dept,Num)|Rest],Semester,Maxsemester,Maxhours) :-
      Semester <= Maxsemester,
      scheduled(Dept,Num,_,Sem),
      Sem <= Maxsemester,!,
      schedule(Rest,Semester,Maxsemester,Maxhours).
schedule([(Dept,Num)|Rest],Semester,Maxsemester,Maxhours) :-
      Semester <= Maxsemester,
       sem_num(Sem,Yr,Semester,_),
      check_standing(Dept,Num,Semester),
      offered(Dept,Num,_,_,Sem,Yr),
      check_prereq(Dept,Num,Semester,Maxsemester,Maxhours),
      check_coprereq(Dept,Num,Semester,Maxsemester,Maxhours),
      add_in([(Dept,Num)],Semester,Maxhours),
       schedule(Rest,Semester,Maxsemester,Maxhours).
schedule([(Dept,Num)|Rest],Semester,Maxsemester,Maxhours) :-
      Semester1 is Semester + 1,
      Semester1 <= Maxsemester,
      schedule([(Dept,Num)],Semester1,Maxsemester,Maxhours),
      schedule(Rest,Semester,Maxsemester,Maxhours).
schedule([(Dept,Num)|Rest],Semester,Maxsemester,Maxhours) :-
      nl,nl,write('  Impossible to schedule '),
      write(Dept),write(' '),write(Num),nl,
      schedule(Rest,Semester,Maxsemester,Maxhours).
schedule([],_,_,_) :- !.
```

Figure 2. Prolog code for the main algorithm

"check_coprereq" check to be certain that pre- and co-requisites have been scheduled prior to (or during, if appropriate) the semester being considered. "add_in" actually places the course in question into the list for the semester.

The Program in Action

Certain information must be entered before the program can schedule a student, and the student must make certain decisions. All of these actions are done interactively from a menu of choices, in color:

1. The student indicates the year of the catalog which contains the graduation requirements he/she plans to satisfy.
2. The student selects a program of study from among those in that catalog. The program adds the appropriate file to the database.
3. The student enters his/her name and identification number. If he/she is already on file, then "old" data on the student is retrieved and used in the next step.
4. The student is asked to indicate which courses, from among those required, that he/she has already taken or is taking now. Old data from step 3 saves time for students who have used the system before.
5. The student indicates in which semesters he/she plans to be in attendance at the institution.
6. The student either has the program go on or he/she returns to any previous menu to adjust the choices already made.
7. The student indicates the maximum number of required credit hours he/she wants to take in any one semester. The program then prepares a schedule for the student.
8. As each schedule is displayed on the screen (see Figure 3), the student chooses to print a copy (or copies) or it, save the schedule to a disk file, or produce another schedule (through backtracking). The student can also return to step 7 to see if changing the maximum number of required credit hours will make significant scheduling differences.

Effectiveness of the Program

For a couple of semesters I have been field-testing the program during student advising sessions. The slowest schedules were produced after a wait of nearly one minute, for a particularly tricky case, while using an old 80286-equipped machine. Other than that anomaly, the program prepares excellent schedules in a matter of a few seconds, and I was not able to duplicate—or verify the correctness of—the program's schedules in less than four or five minutes. One of the first three schedules produced by the program has appeared to be "optimum" in every case; subsequent schedules have had too many courses scheduled in certain semesters.

The program was written to run on IBM-compatible PC's because of their widespread availability. The difficulties with linking this program to the University's mainframe (and its student academic records) were simply too difficult to overcome.

I am in the process of expanding the use of the program to the entire department, and I am also making it available for students to use without faculty help. The basic Prolog scheduling algorithm is not changing appreciably, but the user interface is being made more attractive and user-proof. I am also preparing code that will interactively create the databases necessary for other disciplines to use this program. Within six months this program will be available (and likely in use) in departments throughout the School of Science—and possibly in the School of Business and the School of Nursing as well.

The program is both most efficient and produces the best schedules when the list of requirements in the database is prepared in approximately the order one would normally expect a student to take them. In other words, by listing the lower-level courses first and by putting the upper-level electives last, the program is most easily able to perform its function and most quickly produces optimal schedules. Of course, no matter how we order the requirements, the program will eventually find all possible schedules—including the elegant ones!

Two anecdotes are worthy of note. In early testing of the program, I neglected to list a required course for one of the curricula. However, since this course was a prerequisite for a later required course, the program correctly scheduled the "missing" course when it checked the later course for its prerequisites. The program was thus able to correct my omission! In a second case, I changed from a maximum of seven hours to ten hours per semester, and the next schedule contained a non-required course in the first semester. I was certain that something was wrong—and then noted that this allowed a course with a variety of prerequisites (including the surprise course!) to be taken a year earlier than was possible if we restricted ourselves strictly to "required" courses. The program produced an efficient schedule that would likely have never occurred to any advisor!

Copies of the Code

Copies of the (latest) complete Prolog code and/or executable code for IBM PC's are available upon submission of a formatted 3 1/2" diskette to the author.

References

Bratko, I. (1990). *Prolog Programming for Artificial Intelligence*, 2nd ed. Addison-Wesley.

Kanal, L. and Kumar, V. (1988). *Search in Artificial Intelligence*. Springer-Verlag.

Malpas, J. (1987). *Prolog: A Relational Language and Its Applications*. Prentice-Hall.

Pearl, J. (1984). *Heuristics: Intelligent Search Strategies for Computer Problem Solving*. Addison-Wesley.

Rowe, N. (1988). *Artificial Intelligence through Prolog*. Prentice Hall.

Sterling, L. and Shapiro, E. (1986). *The Art of Prolog—Advanced Programming Techniques*. MIT Press.

```
                 Schedule #1 for Mathematics/Computer Science Concentration
                        Horace Witherspoon         Prepared 9/23/92

These required courses have already been taken (24 credits):   Spring Semester 1993             10 Hours in the Major
    MATH 201  Calculus I                      4 Credits           MATH 210  Discrete Mathematics             3 Credits
    MATH 202  Calculus II                     4 Credits           MATH 311  Differential Equations I         4 Credits
    MATH 310  Calculus III                    4 Credits           MATH 414  Mathematical Statistics II       3 Credits
    COSC 120  Computer Programming I          4 Credits
    PHYS 221  Physics I                       4 Credits        Fall Semester 1993                9 Hours in the Major
    COSC 220  Computer Programming II         4 Credits           COSC 350  Software Systems I               3 Credits
                                                                  COSC 420  Data Struct. & Alg. Analysis     3 Credits
These required courses are being taken (12 credits):              MATH 465  Math. Models & Applications      3 Credits
    COSC 250  Microcomputer Organization      3 Credits
    COSC 303  Scientific Computing            3 Credits        Spring Semester 1994              9 Hours in the Major
    MATH 306  Linear Algebra                  3 Credits           COSC 450  Software Systems II              3 Credits
    MATH 413  Mathematical Statistics I       3 Credits           COSC 456  Advanced Computer Hardware       3 Credits
                                                                  MATH 471  Numerical Methods                3 Credits
```

Figure 3. Sample Output from the Program

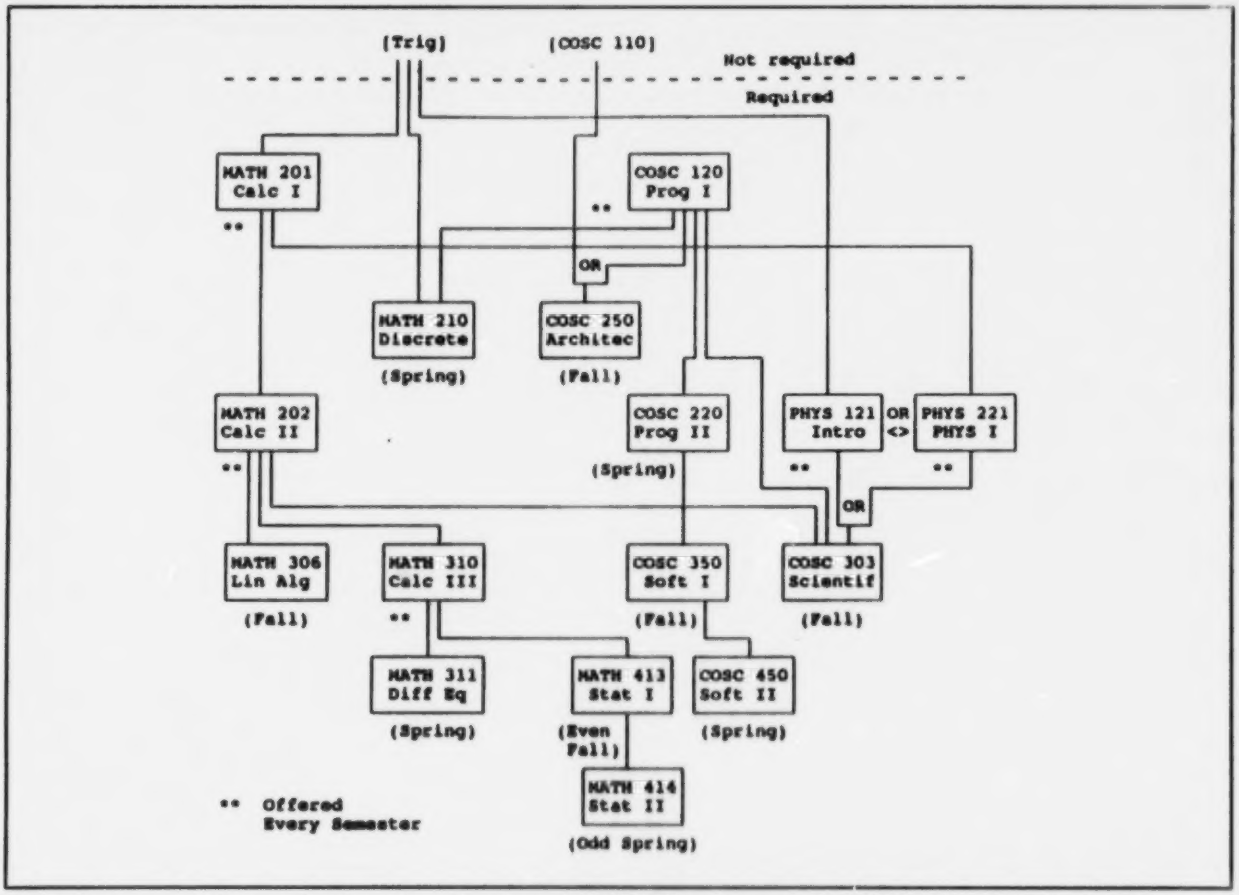

(Trig)
(COSC 110)
Not required
Required
MATH 201 Calc I
**
COSC 120 Prog I
**
OR
MATH 210 Discrete
(Spring)
COSC 250 Architec
(Fall)
MATH 202 Calc II
**
COSC 220 Prog II
(Spring)
PHYS 121 Intro
**
OR <>
PHYS 221 PHYS I
**
OR
MATH 306 Lin Alg
(Fall)
MATH 310 Calc III
**
COSC 350 Soft I
(Fall)
COSC 303 Scientif
(Fall)
MATH 311 Diff Eq
(Spring)
MATH 413 Stat I
(Even Fall)
COSC 450 Soft II
(Spring)
MATH 414 Stat II
(Odd Spring)
** Offered Every Semester

Figure 1. A prerequisite tree showing selected mathematics (MATH), computer science (COSC), and physics (PHYS) courses required in the Computer Science Concentration within the Mathematics Major at Salisbury State University. A course is a prerequisite for a course below if there is a line connecting the two courses, ignoring crossing lines. Also shown are the specific semesters a course is offered (e.g. "Odd Spring" means the spring of 1993, 1995, etc.).

Paper (M1.7d)

A Management Information System for Effective Schools

Donald N. McIsaac
Wisconsin Center for Education Research
University of Wisconsin-Madison

Overview

One attribute of effective schools is frequent and consistent monitoring of students' progress. This has been a stumbling block in many school improvement efforts. One reason is that most teachers receive little training in evaluation and assessment in their programs of preparation and thus are uncertain as to how to interpret data on student progress and to use such data to guide their decisions concerning classroom practice. Another reason is that in most larger school districts data are collected to meet the needs of the central office, not the needs of persons at the school site. A third reason, related to the first two, is that the data maintained in central office databases often are not those that would be most useful in guiding school and classroom level decision-making and even when such data exists, reports often are not available when they are needed. The Management Information System for Effective Schools (MISES) was developed to provide a simple, cost-effective, yet sophisticated way of gathering, storing, accessing, and using data to guide instructional decision-making at the school site.

The application of computer technology to instructional management has deep roots at the University of Wisconsin-Madison. MISES has its roots in the WIS-SIM (1972-1976) project of the Wisconsin Research and Development Center for Cognitive Learning, which was developed in response to the need to find computer-based management solutions for Individually Guided Education (IGE). This was followed by the development of MICRO-CMI, an implementation of WIS-SIM for the microcomputer. The development of MICRO-CMI provided the basis for management software marketed by Addison Wesley and Scott Foresman. These instructional management systems were packaged and sold with K-8 curricular materials in math and reading.

Building on experience gained in these earlier efforts, the MISES program was designed to accommodate a variety of curricular types, models, and efforts. It captures data about educational objectives, instructional skills, program outcomes, test scores, or other items that may be important in assessing student progress. If a management information system is to be effective, it must be simple to operate, provide ready access to prospective users, be maintained properly and updated regularly, and be accompanied by a training program to facilitate learning about its use. The MISES program meets these criteria.

Experience with MISES indicates that the program may be employed in at least three ways. First, it can be used to accomplish administrative tasks , for example, to produce student lists and ad hoc reports. The reports generated by the program can be easily included in other documents because MISES is directly linked to a word processing program. Second, the program can be used to provide information regarding individual student progress, mastery of specific objectives, and assessment scores. These data can be presented in reports to individual students or their parents, or they can be used to prepare reports that reveal strengths and weaknesses in the instructional program which, in turn, can inform decisions made by individual teachers, teaching teams, or a school improvement team. Third, the program is integrated with a powerful array of analytical tools which enable teachers or administrators to conduct research on learning at the classroom or school level.

In our work with the pilot schools, we have learned several things about implementation of the MISES program at the school site.

1. The MISES program should be implemented on a pilot basis. Each implementation site should have at least one individual who has a good understanding of computer operation and the DOS operating system who can provide assistance and support to the school staff.
2. A facilitator should be available to guide teachers as they learn how to use data to do their own analyses. Although very few classroom teachers now have these skills, they are easy to learn if teachers receive instruction and guidance in their initial efforts.
3. The results of analysis of data and its interpretation should be provided to teachers who use the information to decide what adjustments should be made in the program.

Administrative Uses

The MISES program connects to a report writing program that provides users with the ability to generate a variety of reports, lists, and other useful summaries of data. Any field from any file within MISES may be displayed in a report, or used to define or delimit the reporting of other fields. Practical uses abound. For example, a user may wish to disseminate a letter to parents of students in the fifth grade who ride the school bus. With relative ease one may use the MISES report writing capability to choose addresses of only bus-riding fifth graders. The user may then save the addresses in a mailing label format as well as in a mail merge format. The body of a letter may be created in the word processing application of the user's choice and merged with the addresses to create the final letters. The variety of reports available are limited only by the user's needs or imagination: birthday lists, lists of student class members, names of students on district bus routes, to name a few.

Instructional Management Uses

MISES provides users with several tools to streamline instructional management tasks. These tools vary in their comprehensiveness, ranging from simple grade reports to data analysis matrices. Instructional management involves the input of student-related data and the output of reports that provide valuable information that grades alone cannot provide.

MISES allows users to enter into a file information about student outcomes on curricular items for which students are held accountable. Other information related to student performance on specified outcomes may be stored in another file. The intersection of these two files can be used to prepare various reports for users (discussed below). Of course, users may also input data about individual student characteristics as well as create, alter, or rearrange groups of students.

The curricular or outcomes file allows the user to enter a hierarchical sequence of outcomes in a process not unlike that involved in constructing an outline. The top of the outline identifies the broadest category, with increasingly specific categories following in subsequent levels. A sample of outcomes for kindergarten mathematics is displayed in Figure 1. As shown, the "Grade Level" for kindergarten is designated as zero. The "Program Outcome" known as number sense is designated as a 1. The two "Core Outcomes" known as count and pattern are listed as 1 and 2 within the subject number sense.

The database files containing the student names and the curricular outcomes intersect in the grading file. In the grading file, MISES users may enter standard letter grades or other notations that reflect the student's status on a given outcome. A sample of the grading input window is shown in Figure 2. In order to reflect mastery on a given outcome, the letter "M" has been entered and the raw score, if applicable, has also been entered.

Figure not available at press time

Figure 1. Curricular Outcomes Display Table

Figure not available at press time

Figure 2. Grade Score File Window

Research Applications

MISES has a rich potential for "in-the-school research," or "experimentation in the classroom." Data stored in the program database can be employed to address a variety of questions of interest. For example, the effect of automobile ownership on the performance of high school students is generally a matter of more than passing interest. Start with the question, "Is there any difference in the achievement scores for students who own cars when compared with those who do not?" Using the MISES program, coupled with the MINITAB statistical program, we have an easy method of addressing this question. First, we select the data items to be used in the analysis. They are achievement and car ownership. (This assumes that the student record contains information about car ownership.) Second, we produce the following statistical table and finally we determine from the data that there is a difference in achievement far beyond what we would expect to encounter by chance alone. Table 1 shows the results.

The analysis of variance table clearly indicates that the difference between the average scores of those who own cars and those who do not (91.12 vs. 107.42) is not likely to be a chance difference. It does not show that owning a car is the reason for the lower performance, but it does suggest that the students who own cars are likely to demonstrate lower performance. The graph indicates the groups are different. The probability (labeled p in the top part of the table) indicates that one would expect to see a difference this large less that one time out of 1000 by chance. Therefore, we may conclude that this difference is not due to chance.

Figure not available at press time

Table 1. Analysis of Variance on Achievement of Students Who Own Cars

Figure not available at press time

Table 2. Analysis of Variance on Math Scores at the End of the Instructional Period

Probably the most important question a teacher can ask is, "How is this particular instructional program doing?" One pilot school district with which we worked engaged in the development of an outcome-based math education program. After the effort had been underway for a period of six months the teacher responsible for the 5th grade math program collected math test data on the students who were involved in this program. These students had been randomly selected from a pool of 5th grade students so the following comparisons could properly be made. (Random selection ensures that the two groups are much alike prior to the experiment.) The result of the six months of instruction using the new method is compared with the standard method in Table 2.

The graph in Table 2 indicates that group 1 scores were higher at the end of the instructional period but the difference is not statistically significant. The probability, .126, indicates the one would expect to find a difference this great 13 times out of 100 by chance alone.

Hardware and Software Requirements

The MISES program operates on any MS-DOS compatible computer with the following specifications

	Minimum	*Recommended*
Memory	640KB	2MB
CPU	8086 (slow)	286
Mass Storage	30MB	40MB
Monitor	Mono	Color
Printer	Epson FX850	Epson FX850
Network	Not Required	Possible
Scanner	Any Scantron	Any Scantron
Modem	1200Baud	2400/9600Baud

The program will operate either on a network or on a dedicated machine. Some problems may be encountered when running on a network because the program requires a large number of files to be open simultaneously. The system administrator should know how to accommodate this. Unless the system is to be accessed from a variety of locations, it is not necessary to run it on a network. However, all the necessary record locking routines are included in the program and it will run on any DOS compatible network. It has been intensively tested on a Novell 3.15 network, which was the development environment.

Theoretically, the program will run on any DOS 2.0 system or higher. It has been run most extensively on DOS 3.1 or higher. The program utilizes the Clarion Report Writer to provide ad hoc report generation and can be used with either the Clarion Professional or Personal Developers to provide additional program capability. The output files are specifically designed to run with Minitab, but with nominal editing they can provide data input for any statistical or graph producing program (SPSS, BMDP, SAS, etc.). Since the transfer is through ASCII files, it is also possible to enter the data into any program or system that can accept these files. The recommended inferential statistics package is Minitab.

Training Available

Four-day workshop on administrative uses of MISES, including file management, database use, and streamlining administrative tasks. Five-day workshop on instructional management and research uses of MISES, including instructional analysis, data-enhanced decision making, and research design.

Projects (M1.8)
Teacher Training

A Classroom Instructional Technology Center Can Revolutionize Learning and Teaching

Robert H. Reeve, John W. McBride, and Ernesto M. Bernal
University of Texas
Edinburg, TX

Carl L. Hoffmeyer
Edinburg Consolidated Independent School District
Edinburg, TX

M. Akraam Rana
Weslaco Independent School District
Welasco, TX

Ron Pontius
Region One Education Service Center
Edinburg, TX

Abstract

Last summer at the University of Texas - Pan American, ten elementary teachers enrolled in two graduate courses, one in technology dealing with the broad spectrum of media and technology systems with an emphasis on a portable notebook computer, and other course in science teaching. The teachers brought their PowerBook 170s, supplied by their ISD's, to the classroom and tied-in with the Classroom Instructional Technology (CIT) Center. The planned CIT Center consisted of a Macintosh PowerBook, a telephone line, inputs from a printer and a 27" multimedia monitor. This past academic year each of the teachers developed a CIT Center in their respective elementary classrooms. With this technology, the necessary software, and a classroom telephone line, the teachers and their students were able to receive, make, store, retrieve, and present diagrams, charts, lesson plans, handouts, spreadsheets, databases, reports, transparencies, slides, pictures, sound, and video. This is a new approach to learning and teaching.

Making Multimedia Multiply: A Teacher Training Project with CD-ROM

Denise Shorey
Jefferson County Schools
Wheatridge, CO

Catherine Williams
Jefferson County Schools
Wheatridge, CO

Abstract

A Cari Perkins Grant in Jefferson County Schools has been designed to train teachers to work with multimedia. This project involves initial training sessions with teachers and then a reinforcement module requiring teachers involved to model what they have learned by teaching to a group of students. The final multimedia products from both teachers and students are collected and distributed to every participant on a CD-ROM. This CD-ROM can be used by students and teachers for ideas, examples and inspiration as they continue to use multimedia in their classrooms.

Model for Creating a Computer-Using Teacher Education Faculty

Neal Topp, Denise Schmidt, and Ann Thompson
Iowa State University
Ames, IA

Many preservice teacher education programs are attempting to incorporate educational technology into all facets of their program. To facilitate technology integration in education courses, many teacher preservice institutions are trying to provide the teaching faculty with the equipment and training to use technology effectively.

One of the goals of the Department of Curriculum and Instruction in the College of Education at Iowa State University is to integrate computer-related technologies in general education courses. In order to meet this goal, the department is in the process of implementing a three year plan aimed at providing all faculty with experiences so they can appropriately integrate computer-related technologies into their instruction. The plan contains four major elements:

1. Providing computers and networking for all faculty and their classes.
2. Providing voluntary workshops for all faculty.
3. Providing support for answering faculty questions.
4. Providing support and models for classroom integration.

A "computer culture" is growing among the faculty who now talk computers in the hall, share ideas for using computers in classrooms, solve problems for each other, and ask students for help in solving problems. Increasingly, faculty members are using computers and computer-related technology in their teaching. By the end of Year 3, it is expected that computer-related technologies will be used as routine tools to expand and enhance each course in the teacher education curriculum. With the successful implementation of this model, students will experience effective use of educational technology and will graduate with a clear vision of how technologies can improve the learning process.

Cooperative Groups: Conjecturing and Technology in the Geometry Classroom

Nancy Zarach
Nottingham High School
Syracuse, NY

Pat Tinto
Syracuse University
Syracuse, NY

Barbara Shelly
Westhill High School
Syracuse, NY

Abstract

This presentation addresses issues connected with the integration of computers into the teaching and learning of geometry in the secondary mathematics classroom. It focuses on students' interactions within specific instructional formats using cooperative group work and the process of conjecturing, and how these interactions shape students' perceptions about learning mathematics.

It is our hypothesis that students' beliefs about mathematics, and therefore their learning of mathematics, is conditioned by their experiences within the classroom. This study thus relies on two theoretical frames of reference, constructivism and social interactionism. The study is also concerned with allowing teachers as researchers to better understand how instructional strategies and the use of technology come to shape student learning of mathematics.

Project documentation includes the use of audio and video tape for both students and teachers. The presentation will address the project findings using the role of the teacher, role of the student, role of technology, role of mathematics, and role of group work as a discussion framework.

This project is a non-commercial venture; it is part of an NSF SGER funded project for 1992-93 and the basis for a NSF Teacher Enhancement project, 1993. The first years of the larger project were reported on at NECC '89.

Projects (M1.9)
Instructional Applications

An Intelligent Simulation Training System

John Biegel
University of Central Florida
Orlando, FL

Abstract

The Intelligent Simulation Training System (ISTS) was developed to be used in training for decision-making when the information is presented on a simulator. The objective was to remove the human instructor from the active content training loop. The ISTS accomplishes its training task through the use of simulation technology, expert systems technology, and instructional systems design.

The ISTS consists of three main components: the simulation, the domain expert knowledge bases, and the knowledge-based teaching system. The latter is a generic system which will allow for the adaptation of the ISTS to any domain wherein the training is done with a simulation. The system takes English language input, translates that into a language the simulation "understands", evaluates that input with respect to its effect on the simulation, responds to trainee requests for assistance, maintains a record of trainee performance, observes the simulation, and warns the trainee of potential problems. A major advantage of developing such a system is that it can act as an advisor, sitting behind the operator and advising on potential problems that the operator may not have observed or dealt with.

Since the ISTS knowledge-based component is generic, it can be used in domains other than those where simulation is the training medium. We are in the process of developing a teacher for an engineering course where the knowledge base is a set of production rules of the IF (conditions) THEN (consequences) type. All mathematical and logic-based subjects can be presented as rule-based systems.

This presentation will present the structure of the ISTS and a brief discussion of its use.

This abstract was taken from the author's originally submitted proposal

Authentic Assessment in the Technology-Based Classroom: Using Student Response Journals

Beverley E. Crane
San Jose State University
San Jose, CA

Abstract

While response journals have been used effectively in ESL and language arts classrooms, their use in the technology-based classroom has not been explored. Our work is based on a semester-long case study at an inner-city elementary school to examine the benefits of using response journals as an assessment tool in the technology classroom. Fourth graders wrote journal entries after each class session based on a series of open-ended questions. We completed a content analysis of the journals at the end of the semester, identifying the following four categories of responses: (1) curriculum—content and technical expertise; (2) relationships—interaction between student partners, with teachers, and with others involved in the project; (3) student responses to working with technology; and (4) student self-assessment of capabilities in the technology-mediated classroom. As in the ESL and language arts classroom, the response journals proved to be extremely useful not only as a communication tool, but also as a data source to guide instructional planning.

Teachers and Telecommunications: Policy Implications of a National Survey

Margaret Honey and Andres Henriquez
Bank Street College
New York, NY

Abstract

During 1992, the National Center for Technology in Education conducted a nation-wide survey of K-12 educators' use of telecommunications systems for professional enhancement and student learning. The survey was designed to gather a systematic profile of the range of activities currently being undertaken by teachers in order to adequately advise school officials, policy makers, industry, and teachers themselves on strategies for the creative use of this technology. Based on the responses of 550 educators representing 48 states, this survey represents the first systematic and large-scale profile of the benefits and obstacles to using telecommunications effectively as a professional resource and learning tool.

In this presentation we will summarize the implications of our findings as they pertain to policy decisions at district, state, and national levels. For both student learning and professional enhancement activities, we will discuss the factors that contribute to the successful use of telecommunications systems, the incentives that educators' experience in using telecommunications, the impact of telecommunications on teaching, the resources that educators use to learn more about telecommunications, and the major barriers that effect the successful implementation of telecommunications activities in these educators' schools.

Project Egret: Traveling the World's Electronic Bicycle Paths: Interactive Electronic Learning

Sandra McCourtney and Sally Lucke
EGRET International
Sarasota, FL

Abstract

Following a brief review of the literature, the presenters will demonstrate how learner-centered PC environments provide national, international and local on-line capabilities. Groups of students from geographically distant classrooms can collaborate on content-based projects, placing learning in a relevant meaningful context and promoting cultural diversity, language learning and critical thinking.

Integrating Multimedia Applications into the Curriculum Using IBM Technology

Brian Scarbeau, Becky Thornton and Glen Ricci
Lake-Sumter Community College
Leesburg, FL

Abstract

The purpose of this session is to introduce multimedia and to demonstrate how this application could be used in the classroom. Multimedia is an exciting new software application that allows the user the ability to convey messages that mix a number of media including audio, video, text, numerical data, and graphics. There are several programs that are presently available that use multimedia in their applications with CD ROM or laser disc technology. Multimedia application is ideal for teachers to use in the classroom. Lessons can be designed the way you want to present them and utilizing sound can enhance your subject content. This workshop will help you learn how you can begin to implement multimedia applications into your courses using IBM personal computers. The purpose of this workshop is to share with faculty how Lake-Sumter Community College will implement multimedia applications into the curriculum. Workshop participants will learn how Lake-Sumter Community College will be integrating multimedia in the Computer Science, Art, and Music Departments.

Projects (M1.10)
Potpourri

LEGENDS: Using Multimedia to Explore Native Cultures

Gene Bias
Orange County Public Schools
Orlando, FL

Abstract

Students from Edgewater High School, Orlando, and Pine Ridge High School, South Dakota, have joined together to become authors in developing computer and multimedia programs which enable them to explore their cultural differences. The Oglala Lakota (American Indian) students are sharing tribal legends with the students of Edgewater. Edgewater students, in turn, share their cultural differences so each group will better understand the other. Students routinely communicate via Applelink. Both groups are videotaping aspects of their culture that are being incorporated into QuickTime™ movies for HyperCard programs which can then be shared with other schools. Additionally, the students are compiling and pressing the information into CD-ROMs which will be interactive with the HyperCard stacks. These will be available to schools across the nation and throughout the world in the near future. Interactive laserdisc projects are planned for the future. Student visits between schools are planned for the spring. Other schools are being invited to participate in the LEGENDS project so that cultures of various Native peoples can be shared across the nation via HyperCard and CD-ROMs. Samples of student work will be demonstrated to the audience.

Multimedia Director's Primer: Implementation Strategies for the Classroom Teacher

George Blakeslee
Lesley College
Cambridge, MA

Abstract

Teaching and learning through participatory multimedia experiences creates classroom settings in which teacher and student are functioning in non-traditional ways. The level of comfort with these new approaches varies widely among teachers, administrators, students, and parents. Addressing concerns raised by such non-traditional school environments has led to the development of a structured implementation strategy which educates the school community about, and builds support for, classroom multimedia projects.

Organized in the form of a "primer", teachers can design, buil, support , and conduct a multimedia unit. The "primer" outlines five stages from initial idea through final presentation. Setting the Stage defines goals, describes learning activities, clarifies outcomes, and gains administrative and parental support. Preparation addresses classroom configuration, student management, permissions, releases, hardware, and software. Planning follows with locating information sources, building resource centers, and scheduling library work, guest speakers, and field trips. Conducting the multimedia unit necessitates the facilitation of student research, selection, organization, and citation of relevant information. A production "storyboard" is created, and a production schedule is set-up. Success requires careful planning of who does what with which (usually scarce) equipment and materials where and at what time. Sharing the student products is the essential conclusion of this approach to learning.

Multimedia Lesson Planning with *Electronic Chalkboard*

Vicki E. Hancock
Curriculum/Technology Resource Center, ASCD
Alexandria, VA

Abstract

The Curriculum/Technology Resource Center (C/TRC) at the Association for Supervision and Curriculum Development (ASCD) has developed a multimedia tool for educators. *Electronic Chalkboard* is a software tool for the Macintosh designed for use by teachers and students to create multimedia lesson plans, develop portfolio entries and presentations, and conduct assessment activities.

For teachers, *Chalkboard* makes it easy to create multimedia lessons for classroom, small-group, or individualized learning. "Chalkboards" take only minutes to prepare as the teacher retrieves musical scores, archival footage, photographs, maps, and text-based information from school and library resources already on hand. The teacher then cuts and pastes to edit lessons and include self-developed worksheets, tests, or lecture material. The program's "library" feature lets teachers share lessons or store them for later retrieval and repeat viewing. A barcoding feature lets the teacher play back video segments without using a keypad.

For students, using *Chalkboard* encourages active, integrated, self-directed learning. It is an ideal tool for assembling multimedia portfolios, presentations, and performance assessments. Using a graphic interface, students can quickly access a writing sample, artwork, or audio/video material, and simple point-and-click functions let students revise quickly and easily.

Magic Formula for Motivation: Technology & Real-World Projects

James Scalise
John F. Kennedy High School
Metairie, LA

Abstract

Share the fresh enthusiasm of urban high school students in the fast-paced review of their award-winning multimedia projects.

Shelve traditional textbook exercises. Instead, put advanced technology in the hands of otherwise apathetic students, together with a real and meaningful problem to use it on, and something magical happens. Students discover unknown talents and suddenly see themselves in unexpected new roles: as architects, engineers, scientists. Then stand back and watch excitement — and achievement— soar.

Examine the following successful classroom projects, blending computer-aided-design curriculum, desktop publishing, desktop video and animation; learning experiences in the solution of community-based problems:

- Computer-aided designs, drawings, and presentations of a sports stadium for New Orleans Public Schools. This project earned the presenter the 1992 Teacher of the Year Award from IBM and Technology & Learning magazine with considerable student exposure in local and national newspapers, magazines and television appearances.
- Computer generated simulations and animations of the potential destruction of New Orleans by major hurricane scenarios, together with planning for evacuation.

Consider how your own imagination, curriculum and technology can be focused on community projects for your students with equally exciting results.

Projects (M1.11)
Hypermedia

Clicking Your Way Through Interpersonal Conflict

Eileen Bergeron
Florida Diagnostic and Learning Resources System
Tampa, FL

Abstract

Using computers to enhance the social skills curriculum is the focus of this demonstration. Through the use of the Macintosh computer and HyperCard, students learn to behave appropriately and effectively in interpersonal conflict situations. Students accomplish this goal by identifying interpersonal conflict situations, brainstorming to generate alternative ways of responding to one of the situations, discussing the possible consequences of the responses, role playing to test the possible consequences, and visually representing this exercise on HyperCard.

This project has been successfully implemented in six Hillsborough County Classes for Emotionally Handicapped and Severely Emotionally Disturbed. Samples of the students' HyperCard stacks and teacher support material will be presented. A sample stack will be available to participants in exchange for a 3.5" double density disk.

A Hypermedia Project: A Native American Cultural Bridge at UC Irvine

Kimberley Burge
University of California, Irvine
Irvine, CA

Abstract

An eagle, wings spread, appears in the bottom left corner of the computer screen. With the sound of a shrill cry, the wings move and the bird "flies" diagonally across the screen. The young creator, Stanford Belinte, smiles shyly as the surprised computer instructor, Valerie Hackbarth, asks, "How did you know how to do that, Stanford?" With only rudimentary scripting instruction, this Navajo youth has become more accomplished in this "Western" medium of computer graphics than perhaps any adult in his community. This was just one of many magical moments in the Native American Tribal Histories Hypermedia Project.

During the summer of 1992, one hundred sixty Native American honors students used computers in the Department of Education in the University of California, Irvine to bridge the past, present and future. A grant from the Education Foundation of America helped to bring the twelve to fourteen year old students, representing tribes throughout the United States and Canada, to spend six weeks on the UCI campus. These students left their family, friends, and the shelter of their respective communities including the Acoma Pueblo, Hopi and Rosebud Sioux tribes, the Navajo and Oklahoma Cherokee nations, and the Alaskan natives to name just a few. Here in the campus classrooms and labs, cultures blended in cohort groups as students attended mathematics, science, English, ethnohistory, and computer literacy courses in the Native American Intertribal University Preparatory Program. The mission of the program, lead by Richard P. Ettinger Jr. of the Education Foundation of America, John M.Whiteley, Professor of Social Ecology, and Kogee Thomas of the UCI Office of Relations with Schools, was to address some of the problems that Native American students have in preparing for university-level education. These students often need communications and other skills and confidence to move from rural cultures into the mainstream. This can be an intimidating process, and our experience showed that computers can be used to help students bridge the gap.

Initially the computer workshops were designed to support the rest of the instructional program in this six week "instant school". The computer literacy workshops were taught by recent graduates of the Department of Education teacher training program and were held in the department computer lab. The students studied about their tribal cultures in the ethnohistory classes, conducted research in the UCI Library via telecommunications, and used HyperCard text and graphic tools to integrate this information into hypermedia stacks. Soon the computers and software provided the students with a very personal medium of communication. The student stacks included family photographs, scanned images of cultural arts and crafts, and used audio, video and text to retell tribal histories and folk stories in their stacks. Several of the students developed skills beyond the initial objectives of the program and produced QuickTime snippets integrating video interviews about their hopes and dreams for the future.

This integration of curriculum areas and computer-based materials was not "automatic"; it was the result of careful planning by the program staff. In addition to three computer lab trainers, twelve NAIUP faculty members were recruited from more that fifteen hundred secondary school applicants. They arrived at UCI just one week before the Native American students and set to work immediately to create an "instant school." During this preparation week the computer lab staff conducted workshops for the new faculty, introducing them to the computer literacy skills that their students would be learning in word processing, hypermedia, and videodisc operation. This process of sharing resources and ideas between the content-area faculty and the computer lab staff resulted in collaboration in the production of tribal histories HyperCard stacks.

This presentation will include a description of the first year program, including lessons learned by students and staff alike, examples of student products, and plans for the 1993 summer program.

Zapping the Hypermedia Zoo: Evaluation in a Constructivist Learning Environment

Vito M. Dipinto and Sandra V. Turner
National-Louis University
Evanston, IL

Abstract

The purpose of this presentation is to describe a student-centered approach to evaluation of students' hypermedia projects in a constructivist learning environment and discuss its impact on student learning. In the Hypermedia Zoo Project, seventh-graders learned to use HyperCard to create multimedia research reports about mammals as part of their science curriculum. The evaluation process becomes a logical extension of working in a student-centered culture where collaboration among its members is an expressed intrinsic value. Evaluation of students' stacks took three forms: teacher evaluation, peer evaluation, and self evaluation.

This presentation will highlight a student stack and the impact of the evaluation process on its content and design. Videotape excerpts from the teacher evaluation of the stack and selections from students' self evaluations are included.

Interactive Multicultural Counseling: Role Playing Environment

Ronna Olivier, Margery Neely, Chandima Cumaranatunge and Seree Weroha
Kansas State University
Manhattan, KS

Abstract

Counselor training programs are expected to offer training for cross-cultural interaction with clients. The training, particularly on predominantly white campuses, can be enhanced by this interactive program.

Observation of role-playing in typical multicultural counseling classes showed that the trainees were interpreting certain textbook statements literally. For example, certain typical criticisms of traditional counseling strategies are offered by authors of cross-cultural counseling texts. One typical criticism states that counselors must be "more active" with certain minority clientele groups. The trainees interpret this literally as sanction to give advice immediately after a client starts stating his/her problem. The trainees forget that they must first seek to understand the worldview of the client, including environmental factors that impinge upon lives. An additional problem is that textbook examples do not convey the same nonverbal message for different trainees because the voice-tone is missing. In role-playing similar situations, the trainees seemed to believe the client was child-like and submissive, resulting in the trainees coming across as patronizing.

This project, designed using HyperCard and digitized video, is a role-playing environment where the user (student counselor) conducts a counseling session with a simulated client of another culture who responds through digitized video. The counselor chooses different queries to which the client responds in varied ways. At the end of the simulated session the student counselor will be able to access an explanation as to why the client responded in a particular way to each query. The students queries will also be compared to an ideal session which will be used as a basis for evaluation.

The goals of this project are: 1) to provide counseling trainees with voice-tone used as the client's problem is stated; 2) to allow trainees a choice of responses that have different intentions; 3) to provide a sequence of these couplets as a counseling session develops; and 4) to furnish feedback indicating the number of choices of each type of intention, including those designed to provide a perspective of the client's worldview.

Projects (M1.12)
Instructional Software

Using Interactive Mathematics Texts as Teaching Tools

Marcelle Bessman
Frostburg State University
Frostburg, Maryland

James E. White
University of North Carolina
Chapel Hill, North Carolina

Abstract

The Interactive Mathematics Text (IMT) provides a seamless learning environment wherein a student can explore mathematical ideas, computationally and graphically, as well as obtain needed background information and procedural instructions. Within the context of a particular topic (for example, translation of functions), the user can pose his/her own problems, create or alter equations and functions, and actively observe their mathematical behaviors. The basic textbook can be readily created by the teacher for student use.

Examples of textbooks covering topics in algebra, calculus, and physics, and their classroom use will be presented. The development of such textbooks will be discussed.

There are various versions of the IMT. Some are based on using a particular mathematical software, such as **Mathematica** or **MathCAD**. The version used here, however, is based on the symbiotic integration of specially created mathematics clips (utilities) with a Windows-based presentation software package, **Toolbook**. These utilities can also be used with other Windows-based programs. The software used, **MathKit**, is being developed by James E. White of the Institute for Academic Technology (University of North Carolina, Chapel Hill) in Durham. This software can do two and three dimensional graphing and simple, iterative, or recursive computation. It is "powered" by an artificially intelligent infrastructure or "inference engine." **Toolbook** has multimedia capabilities that allow the use of sound, video, and animation. The integration of the two programs permits not only multimedia-enhanced presentation of mathematical ideas, but also user-controlled experimentation with given data and the real time collection and analysis of experimental data.

The manual is being developed by White and myself, in consultation with the Project CALC authors, David Smith and Lawrence Moore.

Water Wizards

Sarah A. Finigan
Samuel Adams Elementary School
Boston, MA

Abstract

Water Wizards is a school-wide project which teaches students ways to reduce pollution by doing "hands-on" science newsletters, making big books, entering essay writing contests, and using databases and graphing software. Students videotape and edit science experiments and student produced shows. They will also videotape a science fair and awards day. The program is thematic across the curriculum - math, science, language arts, history, social studies, art, and computers. The project was funded by the Bank of Boston School Initiatives Grants Program.

The Adams Elementary School has a partnership with the Massachusetts Water Resources Authority through "Creating Lasting Links." Lesley College, The Boston Private Industry Council, and the Boston Public Schools have coordinated a National Science Foundation Partnership Grant which paired elementary teachers with scientists working in local industries. Teachers and scientists developed a mutually supportive relationship through a two week partnership experience at the scientist's place of work and a science curriculum enhancement project for the teacher's classroom. Adams Elementary has also been working with Tufts University by having a student intern work with Adams students on science experiments.

Use of Educational Technology in Engineering Case Studies

Thomas T. Liao
SUNY at Stonybrook
Stonybrook, NY

Abstract

In each of four engineering case studies, advanced educational technology is used to provide students with powerful tools for studying and finding solutions to questions and problems. Students are provided with examples of how engineers use computers to design and study the behavior of systems.

In the Auto Safety case study, several activities use microcomputers. Students use a computer simulation called "Yellow Light" to study the timing of traffic lights at an intersection. A microcomputer-based lab uses a motion sensor to study how a model safety car is moving prior to and during a collision. A television camera is also used to videotape the collision between the model vehicle and a wall.

Two computer-based activities are used to help students learn about the ergonomics of the TV picture. In a case study entitled "Vision and Television," students first learn about "Persistence of Vision" by controlling the rate that two colors flash to make a purple color. Another computer program is used to help students determine how well they see detail at a distance. These computer activities help students to answer the following questions about the TV standards that were set over fifty years ago:

1. How many pictures per second?
2. How many lines per TV picture?

In the "Machine Automation" case study, students use the Fischer-Technik modeling system to build models of industrial systems that are automated. Students build subsystems and combine them into systems for carrying out certain functions. A BASIC program is used to provide computer control of the systems that has been designed and built. Besides program control, simple feedback control is also used to automate the systems.

Students use CAD (Computer-Assisted Design) systems to help them design an emergency shelter for hikers who are trapped on a mountaintop. In this case study, students also use temperature probes to experiment with insulation properties of different materials. Finally, a spreadsheet program is used to carry out what-if investigations about performance of the shelter.

Projects (M1.13)
Educational Software

Image Processing for Teaching: A Teacher's Perspective

S. Hardesty, R. Kolvoord, R. Greenberg, M. Magisos, R. Strom
Lunar and Planetary Laboratory
University of Arizona
Tucson, AZ

Abstract

The Image Processing for Teaching (IPT) project, sponsored by NSF, Apple Computer, and the University of Arizona, provides a powerful medium to excite students about science and mathematics, especially children from minority groups and others whose needs have not been met by traditional "coded" ways of teaching these subjects.

Using professional quality software on microcomputers, students explore a variety of scientific data sets, including biomedical imaging, Earth remote sensing and meteorology data, and planetary exploration images. They also learn about the many mathematical concepts that underlie image processing, such as coordinate systems, slope and intercept, pixels, binary arithmetic, along with many others. We have developed curriculum materials in all areas of mathematics and science for the upper elementary and secondary levels, allowing this tool to be used across a variety of grade levels and student interests.

Preliminary indications show image processing to be an effective and fun way to study the application of science and mathematics to "real world" situations, as represented by digital imagery. The use of image processing is also an innovative method with which to engage students in inquiry and discovery learning.

In our presentation, we will describe our program and demonstrate image processing. We will also discuss our dissemination efforts and show how you can get involved in this exciting program.

This abstract was taken from the author's originally submitted proposal

---

The Image Processing for Teaching Project

R. Kolvoord, S. Croft, R. Greenberg, M. Magisos, R. Strom
University of Arizona
Tucson, AZ

Abstract

The "Image Processing for Teaching" (IPT) project, sponsored by NSF, Apple Computer, and the University of Arizona, provides a powerful medium to excite students about science and mathematics, especially children from minority groups and others whose needs have not been met by traditional "coded" ways of teaching these subjects.

Using professional quality software on microcomputers, students explore a variety of scientific data sets, including biomedical imaging, Earth remote sensing and meteorology data, and planetary exploration images. They also learn about the many mathematical concepts that underlie image processing, such as coordinate systems, slope and intercept, pixels, binary arithmetic, and many others. We have developed curriculum materials in all areas of mathematics and science for the upper elementary and secondary levels, allowing this tool to be used across a variety of grade levels and student interests.

Preliminary indications show image processing to be an effective and fun way to study the application of science and mathematics to "real world" applications, as represented by digital imagery. The use of image processing is also an innovative method with which to engage students in inquiry and discovery learning.

In our presentation, we will describe our program and demonstrate image processing. We will also discuss our dissemination efforts and show how you can get involved in this exciting program.

This abstract was taken from the author's originally submitted proposal

Diversity by Design

Terri Meade and Kathy Powell
Bank Street College
New York, NY

Abstract

Images of varied influences and expressions are constants in both everyday and educational life. From printed advertisements on billboards to video images on television sets; text book illustrations to the images incorporated in computer software products, we are continually seduced by "the visual." How each individual "tunes" into, interprets and derives meaning from any particular visual image is determined by that individual's personal and cultural frames of reference. These may be shaped by variables such as ethnicity, skin color and race as well as art, language, and education. As members of a culturally diverse society, we must recognize the multiple cultural perspectives that are available. Imposing a singular cultural perspective is both limiting and undesirable since it does not reflect varied experiences.

This presentation will illustrate the relationship between culture, metaphor, style, and visual imagery. Our formative research addresses issues that will help to shape and define the elements that designers must consider if they are going to begin to incorporate diverse perspectives into the conceptualization and design of educational media. Included will be an overview of our findings related to assumptions, misconceptions, and stereotypical perceptions and their relationship to designs for learning. We will also discuss ways that metaphor can be used to negotiate differences and make connections between and among cultures through the use of visual imagery. The analytical framework is a research and design model that aims to illuminate consistently under-represented African perspectives, while attempting to bridge the diverse voices and experiences that make up the American experience.

Media designers and educators provide a host of visual images to their respective captive audiences. It is important for them to begin to examine the types of visual images of the worlds that they provide; to consider how their choices of images can possibly differ from the visions of the worlds that are seen and understood by their respective audiences. The creators of educational media need to explore new ways to illustrate the process of learning so that new meanings might be illuminated, not obscured by the design of media. They need to allow learners to begin from the learner's own "place" and to provide opportunities for the learner to create new meanings relative to that learner's cultural reality. The visual image provides an opportunity to construct that conceptual bridge. It can provide one of the tools for communication across cultures making negotiating the fundamentals of cultural differences an issue yielding outcomes that are positive and successful as well. As visualized information becomes more and more common, the subtleties of creating and interpreting visual images for their diverse cultural meanings needs to be much more thoroughly explored and more deeply understood by all those who design materials for education.

Because all learning takes place within a cultural framework, it is imperative that media designers investigate, understand, and incorporate the appropriate "ingredients" of diverse cultures into the design of products. The proposed workshop is based on our work, entitled ***BRIDGES, Structuring Visual Notions, Expanding Perceptions of the Learner***. **BRIDGES** is a design notebook that visualizes an African-centered cultural perspective. An African-centered cultural perspective embodies a worldview based on Africanate systems of knowledge and values realized through self-knowledge. It is a way of looking at, thinking about, understanding, seeing, and ordering the world, assuming "self" as the primary point of reference. Knowledge and understanding of self is the first step towards being able to "know" others. This philosophical perspective encompasses the use of images and systems of communication derived from and compatible with an African-centered socio-cultural matrix.

Our research examines the relationship between culture, metaphor, style (both individual and cultural), and visual imagery from an African perspective. BRIDGES is a resource base for media designers interested in product development for culturally diverse audiences. It models how the above elements can be incorporated into media design by illustrating how a people might represent themselves. The implications for learning explored in our work have applications for all media designers including those of print, electronic, and interactive materials.

In this workshop session we will discuss a framework for practitioners who are interested in designing curricula and media that meet the needs of culturally diverse audiences. The discussion will include the role of developing technologies in the design of curricular materials and ways to provide students with access to alternative forms of communication and expression. The questions addressed by the images used in this workshop will help to shape and define the elements that designers must consider if they are going to begin to incorporate diverse perspectives into the conceptualization and design of educational media. Included will be an exploration of assumptions, misconceptions, and stereotypical perceptions and their relationship to designs for learning. We will also examine ways that metaphors can be used to negotiate differences and make connections between and among cultures by using visual images. The workshop will include hands-on media activities. Materials will be supplied.

Geographical Information Systems for School Administrators

Kenneth Temkin and Paul Cote
Newton Public Schools
Newtonville, MA

Abstract

Newton Public Schools has teamed up with the Massachusetts Institute of Technology's Department of Urban Studies and Planning to investigate educational applications of Geographic Information Systems technology. Geographic Information Systems, referred to as GIS, desktop mapping or data visualization, are computer software programs that tie maps to databases. In the words of one expert, "Using maps and your data together is a powerful way of understanding and communicating your message. Desktop mapping enables you to graphically manage, analyze, and present your data, and view the geographic results of your analysis." In the end, this new technology helps users and administrators make more efficient and effective decisions.

The City of Newton is a suburb of Boston consisting of 19 schools and 9500 students. Newton Public Schools has taken a first step toward using GIS systems by (1) exploring possible applications of GIS for school administration, (2) evaluating various GIS software programs, (3) developing several applications, and (4) preparing a GIS implementation strategy for school administrators.

Posters (M1.14)
E-Mail & Instructional Applications

Using Electronic Mail for Data Collection in Educational Research
Susan Anderson
Texas Christian University
Fort Worth, TX

On-Line Instructional Methodologies for Distance Learning
George Fornshell
NOVA University
Ft. Lauderdale, FL

The Magic of Electronic Classrooms: Promises and Pitfalls
Genell Harris
University of Illinois
Mahomet, IL

Combining Distance Education Technology for Course Delivery
Larry Hudson and Phyllis Olmstead
University of Central Florida
Orlando, FL

Radio/Satellite Technology in Education
Greg Jones
University of Texas
Austin, TX

Spotlight Sessions (M3.1)

Managing Global Learning Projects: On the Internet and in the Classroom / Drinking From a Firehose: Real Life on the Internet (Part I)

Yvonne Andres
Oceanside Unified School District
Carlsbad, CA

Al Rogers
FrEdMail Foundation
Bonita, CA

Abstract

This two-part session addresses some of the exciting aspects of telecommunications on the elementary and secondary levels. Part one, ***Managing Global Learning Projects: On the Internet and in the Classroom***, helps inexperienced teachers entering the Internet deal with a sometimes unfamiliar medium for communications. The session leaders explore ways to find appropriate curriculum-based global learning projects as well as ways to develop and promote project ideas to the right audience of global collaborators. Methods for locating appropriate projects and project management strategies are also covered.

Spotlight Sessions (M3.2)

Managing Global Learning Projects: On the Internet and in the Classroom / Drinking From a Firehose: Real Life on the Internet (Part II)

Yvonne Andres
Oceanside Unified School District
Carlsbad, CA

Al Rogers
FrEdMail Foundation
Bonita, CA

Abstract

This two-part session addresses some of the exciting aspects of telecommunications on the elementary and secondary levels. Part two, ***Drinking From a Firehose: Real Life on the Internet***, presents classroom-tested strategies for locating information, resources, people, and special interest communities relevant to K-12 teachers and their students. *CERF'n Safari: A Classroom Users' Guide to the Internet* and *SCHLnet* collaborative curriculum projects will be highlighted. In addition, this part of the presentation will discuss the best ways for classroom teachers to use Internet information search and retrieval utilities such as *Archie, Gopher, WAIS,* and *WWW*, as well as methods for finding human and community resources through *USENET, SCHLnet*, and *LISTSERVs*.

Spotlight Sessions (M3.3)

ACM Model High School Computer Science Curriculum

Susan M. Merritt
Pace University, NY

Abstract

A task force of the Pre-College Committee of the Education Board of the ACM has been working on a proposal for a high school course in computer science since 1989. Three drafts have been distributed to reviewers throughout the country and the world.

The task force identified seven areas to be included in such a course. The seven areas are:

- Algorithms
- Programming Languages
- Operating Systems and User Support
- Computer Architecture
- Social, Ethical, and Professional Context
- Computer Applications
- Advanced Applications

A list of topics is given for each area. These are divided into those essential for all courses, those recommended for inclusion but not essential, and optional topics. In addition, the task force recognized a spectrum of delivery methods, ranging from a concentration on applications to a concentration on intensive programming. The models include:

- Applications based
- Breadth approach using applications and programming modules
- Breadth approach interweaving applications, computer science topics, and programming
- Project development approach using a programming language
- Apprenticeship model
- Advanced placement (AP) computer science.

Course descriptions and syllabi are included as appendices to the report.

From the comments received from reviewers and those expressed at previous panels and workshops, the need for such a course seems clear. High school teachers in particular welcomed this effort. However, the task force recognizes the challenges involved in the implementation of such a course and continues to work on solutions.

Task Force Members:
Susan M. Merritt, Pace University, NY (Chair)
J. Philip East, University of Northern Iowa, IA
Darlene Grantham, Montgomery County Public Schools, MD
Charles Rice, Dalton School, NY
Viera K. Proulx, Northeastern University, MA
Gerry Segal, Bank Street College of Education, NY
Carol E. Wolf, Pace University, NY
Charles J. Bruen, Bergenfield High School, NJ

Spotlight Sessions (M3.4)

Books With No Pencils...NOT!

Roger Wagner
Roger Wagner Publishing, Inc.
El Cajon, CA

Abstract

Your classroom wouldn't have just books and encyclopedias without providing for pencil and paper and student expression. An effective technology plan requires not only the reference multimedia of CD-ROM and online databases, but the creative multimedia of HyperStudio as well. Learn how this one software program serves multiple grades and subject areas. Student examples and related technologies such as laserdiscs and QuickTime will be shown.

Society Sessions (M3.5)

How to Build Your Own Local Area Network
Educational Computing at Minority Institutions (ECMI)
Jesse C. Lewis, Panel Chair
Norfolk State University
Norfolk, VA

Abstract

This session is designed to inform the faculty from minority institutions about campus networking, network management, network support, and network applications. The services and research opportunities provided by MU-SPIN (Minority University-Space Interdisciplinary Network) will be discussed, and information on how to install your own local area network by using a "Networking Starter's Kit" will be provided.

MU-SPIN is a comprehensive education initiative that is oriented around wide area networking technology and its use for supporting multi-disciplinary scientific research. It is aimed at transferring advanced computer networking technology to the under-represented academic community.

Panelists:

Mou-Liang Kung
Norfolk State University
Norfolk, VA

Nagi Wakim
NASA
Greenbelt, MD

Society Sessions (M3.6)

Careers in Computing: Toward a Broader, Gender-free Perspective
Special Interest Group on Computer Uses in Education (SIGCUE)

John D. Lawson
University of Oregon
Eugene, OR

Valerie A. Clarke and G. J. Teague
Deakin University
Victoria, Australia

Danielle R. Bernstein
Kean College of New Jersey.
Metuchen, NJ

Cindy Meyer Hanchey
Oklahoma Baptist University
Shawnee, OK

Abstract

Research findings indicate that women are under-represented in computing careers and computing courses. When women are involved, their participation is often in restricted aspects of computing. Women are generally found at lower levels in the hierarchy and receive lower salaries. Research evidence documenting these trends will be presented. Gender differences in computing participation have been shown to be the result of socio-cultural factors rather than of differences in ability, dedication or aspiration. The panel will identify the socio-cultural factors which are evident at both the broader social level as well as within the home and the typical school. They will suggest strategies which teachers and parents can implement to increase the interest and participation of female students in high school, college, and university computing courses, and will discuss their experiences in developing and using these strategies.

These general principles will be illustrated in relation to at least two programs: first, the design, conduct and evaluation of a holiday vacation program for senior secondary students; and second, the development of a video intended to attract female students to computing courses and careers. The 26-minute video will be screened. Other resource materials will be described and/or demonstrated.

Society Sessions (M3.7)

Move Over Whittle, We're Already Doing It: Are For-Profit Schools a Reasonable Alternative?

Society for Computer Simulation (SCS)

Inabeth Miller
MCET
Cambridge, MA

Abstract

There has been much publicity about the Edison Project and the technology students will learn at these privately funded non-public schools. Technology is already happening in both public and non-public schools. Supported by state and federal funding, assisted by corporations and foundations, students in almost every state are working with their teachers and receiving instruction from several distance learning networks. MCET is at the forefront of this innovative, interactive learning delivery system. Working with more than 2,000 schools in 18 states via its satellite network, MCET covers the full range of educational subjects from science to Spanish, from math to music. While Whittle plans for new technological institutions for the few, MCET's vision of providing non-commercial quality education via the latest technology for ALL students has become a reality.

Paper (M3.8a)
Computer Simulation of Laboratory Instruments Speeds Learning and Reduces Costs

Robert L. Baxter & William R. Moore
Western Kentucky University
Bowling Green, Kentucky

Abstract

Graphical interactive software programs on a personal computer can enhance student comprehension and understanding of typical electronics laboratory equipment and teach its proper operation in less time than in a conventional laboratory setting. By utilizing existing computing equipment to simulate lab instruments, significant cost savings may be achieved as well. The described programs run on low-cost MS-DOS compatible computers having color VGA displays and realistically simulate on the video monitor a conventional lab instrument and all its controls and features. The programs incorporate pull-down menus and numerous expandable windows for explaining and demonstrating proper techniques for applying and using the instrument under investigation.

Each program operates in a tutorial fashion and provides students several options as to how they wish to explore learning about the instrument under study. This allows students individually to determine exactly the right methodology by which they wish to approach the topic and the pace at which they wish to proceed. All major program options are available from visually distinctive pull-down menus and include modules covering: a) the underlying theory of instrument operation; b) how to use the instrument properly for basic measurements; and c) a computer-generated test which measures proficiency and provides immediate feedback. The programs include extensive tutorial instruction on every aspect of instrument operation—placing as much emphasis on basic instrument setup and typical applications for the beginning student—as on explaining and demonstrating more sophisticated uses and applications for students of advanced proficiency. All programs incorporate a testing module to measure student understanding of each covered concept and provide immediate feedback to the student on his or her understanding of program topics. A password-protected instructor's module permits the course instructor to examine the results of each student's proficiency test in all program areas and print out student grade reports as desired.

The programs have been used with great success in the electrical engineering technology program at Western Kentucky University over the past two years to enhance student understanding and use of a variety of laboratory instruments. These programs in conjunction with other specially designed lab assignments have made our students much more proficient in lab equipment operation in a much shorter period of time.

Introduction

In years past many if not most beginning electrical engineering technology students had some prior electrical experience acquired either from military service, a vocational program, or possibly from ham radio or build-it-yourself electronic kits. In those days, many students had been exposed to basic electrical meters, measuring techniques, and often they were even somewhat familiar with oscilloscopes and how to use them. New students today, however, usually have little or no electrical background and are completely unfamiliar with even basic electrical and electronic instruments and measurements.

In the electrical engineering technology program at Western Kentucky University, we have increasingly experienced the need to develop instructional materials to assist students in learning basic laboratory techniques. We have had to prepare a number of supplemental handouts and video tapes covering topics such as: wiring up a circuit, proper circuit layout, measuring voltage, measuring current, circuit loading by the measuring instrument, component characteristics, and the theory and use of the laboratory oscilloscope. While these materials are made available to all students enrolled in the beginning laboratory courses, we continue to see a decline in student ability to perform competently in the laboratory.

In an attempt to improve student understanding and operation of lab instruments, we reviewed our existing teaching aids and rethought what could be done to improve student understanding and comprehension of basic laboratory instruments. We considered additional lecture time on the instruments and even considered video taping a new series of lectures to make them more accessible to students. As we studied this option, it became apparent that while a video taped lecture would ensure consistency and quality of the presentation and provide students the opportunity to watch the tape at their convenience and as many times as desired, there were a number of problems and disadvantages to this approach. Producing a high-quality lecture on video tape requires an enormous expenditure of time, excellent production facilities, and knowledgeable technicians. While the production facilities and expertise are available on campus, it requires a sizable expenditure and a long scheduling lead time. A further disadvantage of video tape is that it is not easily modified to reflect equipment changes, and viewing equipment is not readily available to students at our campus. For these and other reasons, we began to plan to use an MS-DOS compatible computer to produce computer simulations of the most important lab instruments that engineering technology students ordinarily deal with.

Once we decided to use a computer to supplement our teaching of lab instrument principles and operation, we began to realize that the computer had many advantages to offer. It could simulate all of an instrument's operational modes and demonstrate proper measuring techniques on-screen while using variable and randomly changing values to keep the simulation fresh and informative. The programs are designed to be easy for a student to use, not dependent on any one model or manufacturer of laboratory instrument, and to provide comprehensive instruction in the theory of operation of each instrument.

A major advantage of software simulation is ready availability of the program to the students. Computers are available at a number of locations across campus including the main library, and they are available during all hours the library is open. This provides many more opportunities for student access than is possible with the limited number of actual instruments in the lab and the limited hours that the lab is available outside of scheduled class hours.

A second advantage is that any lab instrument simulated on the computer is available at essentially zero additional cost rather than the hundreds or thousands of dollars of each actual instrument in the laboratory itself. The only hardware requirements to run the programs are a low-cost MS-DOS compatible computer having 640 kilobytes of memory and a VGA color monitor.

Figure 1. *This student is using the tutorial mode of the program to understand the function of one of the oscilloscope controls. Three on-screen windows are open to show: (a) step-by-step instructions on how to use the control, (b) a picotrial display of the control being adjusted, and (c) a picture of the resulting oscilloscope display that shows the effect of each control adjustment.*

Description of a Typical Program

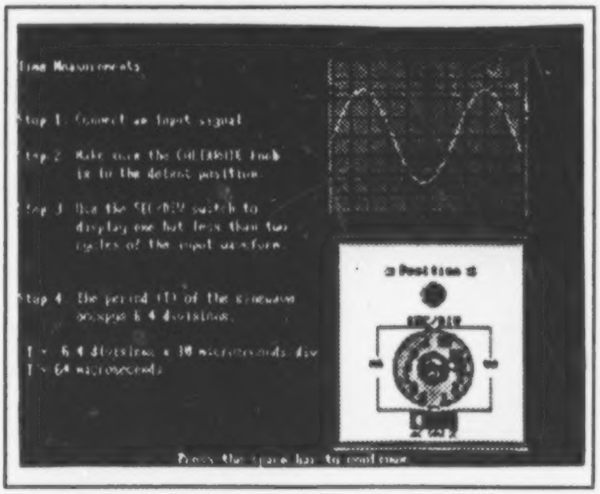
As an example of a typical program simulating the operation of a laboratory instrument, we will discuss and show some examples from a program that teaches students how a typical laboratory oscilloscope operates and how to use it properly. An oscilloscope is the most complex piece of equipment found in an electronics lab and is therefore the most challenging for a beginning student to master. Consequently, an educational program designed to teach a student to use and understand it must make use of a variety of educational strategies and techniques to facilitate comprehension and insure mastery.

The program contains four major areas of activity which a user may select from a pull-down menu continuously displayed across the top of the screen. Function keys and cursor keys or a mouse are used to select the menus and to move between menus. The four major program areas or modules are labeled EXPLORE, LEARN, MEASURE, and TEST. Each of these program modules, in turn, has a number of additional choices available from the pull-down menu. Once a program activity has been selected, the user proceeds from screen to screen by pressing the space bar.

The EXPLORE menu provides the user a general introduction to the oscilloscope, its many applications in the measurement of physical quantities, plus safety considerations that must be adhered to when using an oscilloscope in an electrical circuit. Also available from this portion of the program is a menu-selectable section for use by the course instructor. To enter this section of the program, a password must first be entered for security purposes. Once in the instructor section, the user has the option of reading or printing any or all student scores that have been saved by students running the TEST portion of the program. The student's name along with his or her total score in percent, total number of problems attempted, number of problems answered correctly, and the date the test was taken are stored in a file. There are five different tests administered in the TEST section, and each is stored in a separate file. In addition, the instructor has the option of clearing and resetting any of these student files, or changing the default drive and path for placement of the student files to a particular disk or subdirectory. The EXPLORE menu is also used to exit from the program.

To comprehend how an oscilloscope is designed and how it operates, it is important that students develop an understanding of each of its major component systems which consist of: the display system, the vertical system, the horizontal system, and the trigger system. The LEARN module of the program is designed to let students learn about the operation of each of these major areas of oscilloscope design and operation. The modular program design allows students to work on these major areas in any sequence desired or to repeat a section as often as necessary.

The LEARN section starts with the basics: a detailed explanation of the oscilloscope graticule and how to read it properly. Major emphasis in this section is given to the triggering of the trace and what controls must be adjusted for the trace to appear stationary and stable on the screen. Triggering is explained using an interactive simulation for which students use the "S" key on the keyboard to change the trigger slope and the cursor arrow keys to adjust a variable on-screen trigger level. The effects of either a trigger level adjustment or slope change on the displayed sinewave are instantaneously shown on screen. Other segments of the LEARN section include explanations of how the vertical VOLTS/DIV section of the scope functions, a description of the oscilloscope's horizontal section, and considerations in the use of oscilloscope probes. The LEARN section also includes a subsection outlining a simple procedure for first-time users of the oscilloscope to follow to set up the oscilloscope controls for proper operation.


Time Measurements

Step 1: Connect an input signal

Step 2: Make sure the [illegible] knob is in the detent position.

Step 3: Use the SEC/DIV switch to display one but less than two cycles of the input waveform.

Step 4: The period (T) of the sinewave occupies 6.4 divisions.

T = 6.4 divisions x 10 microseconds/div
T = 64 microseconds

Press the space bar to continue

Figure 2. *Tutorials on each oscilloscope section start with discussion of the function of that section and a block diagram showing how the section works. AT the bottom of every screen, the student is given the option of going forward or backing up to review a particular topic.*

The MEASURE section of the program is designed to show by example how to use the oscilloscope for making measurements of voltage, frequency, period, phase, and pulse rise time. The first part of this module illustrates how to use the oscilloscope to perform amplitude measurements of AC and DC signals as well as signals containing both DC and AC components. The oscilloscope display is realistically simulated on the screen and a typical VOLTS/DIV switch with an input coupling switch is drawn simultaneously in another window on the screen. Students are shown how to measure the amplitude of various waveforms including sine waves, triangular waves, and square waves. Changing the settings of the simulated on-screen oscilloscope controls—such as the input coupling switch, the VOLTS/DIV selector switch, the SEC/DIV selector switch, and similar switches—causes the simulated oscilloscope waveform to change precisely as it would on an actual oscilloscope.

Another option on the MEASURE menu gives the user an opportunity to explore the proper techniques for determining the period and frequency of a waveform. A step-by-step procedure details the steps required to display and calculate the period, frequency, and duty cycle of pulse type signals. This section also utilizes a functioning simulated oscilloscope display screen plus a window containing front panel timebase controls to illustrate the direct relations between the two.

A third choice available under the MEASURE menu teaches students how to use the oscilloscope to measure phase difference between two signals. Students view in sequence the actual steps required to use a dual-trace oscilloscope to measure the phase angle between signals applied simultaneously to the two scope inputs. In addition, phase angle measurement via Lissajous patterns is also illustrated in this section.

The final section of the MEASURE program illustrates the steps required to determine the rise time of pulse type waveforms. This section of the program demonstrates how to adjust the amplitude of the signal so that the standard 10% and 90% lines of the screen graticule can be used. A pop-up window containing the trigger level control is shown and the control is simultaneously adjusted to provide accurate measurement of pulse rise times.

The final major section of the program is the TEST section. It is designed to verify the student's knowledge and mastery of all of the oscilloscope's front panel controls and switches as well as competency in the measurement of amplitude, frequency, period, phase, and duty cycle. Once any test topic is selected from the TEST menu, the student is asked to enter his or her name. The test questions for the chosen section are then randomly presented in a non-repeating sequence using randomly generated values for waveform amplitudes, periods, and other parameters. Whenever the student answers a question, the program responds positively with reinforcement if the answer is correct, or it provides the correct answer if the question was incorrectly answered. After each question, an on-screen scoreboard momentarily appears giving the student a statement of his or her progress on the test via a summary of how many questions have been attempted and how many have been answered correctly. The student may choose to continue answering questions or exit the test at any time. When students finally choose to leave the test section, their overall scores are displayed, and those scores along with the time and date are stored in a student data file on disk.

How the Programs are Used

Students are first introduced to the programs in conjunction with a short lecture and an oscilloscope demonstration at the first laboratory session of the semester. The entire class,

BEST COPY AVAILABLE

divided into groups as dictated by class size, is taken to the computer laboratory where each student works individually with the program on a computer. The students are required to look through the Explore, Learn, and Measure sections of the program at that time. They also take the test on the front panel controls. Then throughout the semester, additional assignments are given to the students which require them to review the Learn section of the program and to complete all of the tests on the various sections of the oscilloscope. For additional reinforcement, written lab reports throughout the semester must now include some discussion of oscilloscope theory and how certain measurements were made.

Students in our sophomore electronic technology courses are also required to work through the program in its entirety and to complete tests on all program sections. We have found this reinforcement of oscilloscope principles and operation to be invaluable since they now have a better understanding of amplifiers, voltage comparators, delay circuits, and other essential components of the modern oscilloscope. Students at this level are more able to comprehend the importance of the oscilloscope and can appreciate the capabilities and uses of this important laboratory instrument.

Beyond the applications of the programs in the beginning courses, even in upper-level laboratory courses we occasionally find a student with a deficiency in the use of the oscilloscope. Such a student is assigned to work through the appropriate section or sections of the oscilloscope program. If the student's test results are below average, a laboratory assistant or lab instructor is assigned to work with the student at the computer to provide additional assistance and to answer questions as the topics are reviewed.

Conclusions

Responses from students have been very positive and enthusiastic regarding the use of these programs. They particularly like the capability of being able to work at their own pace and at a time that is most convenient to them. Not only do they spend the assigned time on the computer working with the programs, but many highly-motivated students spend considerable additional hours working through the programs and taking the program tests to further refine their proficiency and skills. They uniformly report finding the programs extremely useful and they thoroughly enjoy using them.

Paper (M3.8b)
Human/Computer Interface Issues in Educational Computing

Anthony Storms Akins
IBM Federal Systems Company
Houston, Texas

Abstract

The study of human-computer interaction is a relatively new field and is not an exact science. As a result, the work in this field has often been ignored. Systems that ignore the importance of human-computer interaction often frustrate and confuse, instead of instruct. The user interface is the first perception a student has of the system, and it is a lasting one. For that reason, it is very important that the impact of the user interface be carefully considered. The user interface can either enable the educational process, or impede it. As a friend says: what the user sees is the system and what the user sees is the user interface.

This paper provides an introduction to the field of human-computer interaction and considers how human-computer interaction plays a very important, yet often ignored, role in the area of instructional technology. A set of human-computer interaction guidelines and recommendations to aid developers of instructional technology will be presented and explained. The paper concludes with a list of references concerned with human-computer interaction for further study by interested parties.

Introduction

The field of human-computer human interaction is concerned with the study and consideration of the effectiveness of the connection or link between humans and computers. Sometimes referred to as usability, user interface design, or human factors, human-computer interaction is a very broad and interdisciplinary field, attracting people with diverse talents in the areas of classical computer science, software and hardware design, psychology, industrial design, graphic design, and sociology, among others. It is a relatively new field that is attracting increasing attention as computers and similar technology take on larger roles in our day to day lives.

Where we are today

Perception is Reality:—Human factors issues are not limited to the study of interactions between humans and computers. The study of human-factors is concerned with how a human communicates with a system, where a system is literally anything which we interact with. When considering human-computer interaction the system is a combination of the hardware and software that is being used. Communication consists of giving and receiving information to/from the system. The application developer should consider the following questions:

- How does the system make information available to the user (output)?
- How does the system accept information from the user (input)?
- How can the quality and quantity of information communicated between the human and the computer be improved?

In his book The Psychology of Everyday Things, Donald Norman explains the concept of three potentially different models or perceptions of a physical system. The first model is the design model, the designer's concept of how the system will actually work. A user's mental model is the user's mental image of the system and how it operates. The system image is the physical representation of the system (including documentation, instructions and labels). A system image that clearly expresses the goals, concepts and strategies of the design model aids the user in creating an effective mental model. When the system image does not make the design model clear and consistent, the user will often develop an inaccurate or inappropriate mental model. This will cause the user to have difficulties in using the system. (Norman 16)

The user model is the user's perception of the system, and perception is reality. This is a fundamental rule that all designers must remember. No matter what the intent of the designer, the user's perception of the product is what is real, and if that perception differs from the intent of the designer, the fault is in the hands of the designer.

Applying Norman's concept of the three models to the world of computers, the user interface is the system image. It is how the system is presented to the user. It is the user's perception of the system. If the user interface does not present the design model (the goals, strategies and purpose of the system) in a clear and consistent manner, the user's perception of the system and its purposes will be different than what the designer intended. It is in this fashion that the user interface can either be an enabling device, providing a clear communication path between the user and the system, or a disabling device, potentially creating a frustrating and confusing experience for the user.

The Narrow Interface. According to Bill Buxton, the choice of the input device is very important. The input device has a pronounced effect on the complexity of the system and the user's mental model of the system. (Buxton 1991 1.5) The same can be said for output devices. The choice of the input and output devices can either help or prevent the user from developing an effective and appropriate mental model.

The most common input device used today is the keyboard. While effective for certain tasks, it requires the user to possess a certain level of skill to use it effectively. This is true for all of the popular input devices of today. The mouse, joystick and light pen, each with their own set of strengths and weaknesses, require the user to develop a certain level of skill in order that they be used most effectively.

The decision of how information is communicated between the user and the computer is one of utmost importance. Yet, it is a decision often ignored. In many cases the decision is often based on the limitations of the computer hardware.

All of the interface devices commonly used today have a common weakness. Rarely do they recognize the ability of the human brain to handle complex relationships. Consider the following simple devices used in everyday life:

- The single knob faucet where the knob is twisted to adjust water temperature, and pushed or pulled to adjust the flow of water.
- A pencil where, the width and darkness of the line can be varied simply by how hard the pencil is pressed to the drawing surface. (Buxton 1991 1.1)

The interface devices of today can not support such complex interaction. The result are interfaces that provide a very narrow conduit for communication with the computer.

The input devices in common use today provide essentially one dimension of input. The keyboard provides for the input of text, and nothing more. The mouse provides a way to move one's position on the screen or in a document. The joystick and stylus provide many of the same capabilities of the mouse, plus the possibility of recording and recognizing force (how hard was the joystick pushed? how hard was the stylus pressed to the surface?). Tablets used a stylus, puck or finger provide roughly the same capabilities of the joystick or mouse.

All the above input devices require the user to direct his attention from the input device to the output device, in order to see the results of their actions. Over time the user may learn to touch type, or move the pointing device without shifting attention back and forth from the input device to the output device. To be used effectively the user must develop a new skill. Today's common interfaces rarely take advantage of a person's existing skills.

When considering output devices, the situation is much the same. The primary output device is the display. In the last few years the quality of displays has greatly increased, from the ability to legibly display 16 lines of 40 characters each to the ability to display two full pages (60 lines of 72 characters each) on large 19" displays. Yet, the quality of displays is still not as good as a paperback book, where two pages of text can be shown clearly in a seven inch high by 9 inch format when opened. Many displays used today have the ability to display legibly no more than 25-30 lines of 80 characters each. The result is an output device with a very narrow view of the information contained in the computer.

The interface devices of today provide a very narrow communications channel between the human mind and the computer. Combine the narrow bandwidth of the interface with the development of skill in order to effectively use the interface, the opportunity for user frustration is great. The goal of future efforts in the human-computer interaction field should be focused on widening the connection between human and computer in order that the communication can be more efficient and effective.

The Separation of Input and Output. Consider how we converse with each other. Consider how we use pen and paper to record, annotate and collect information. Now compare that to how we use computers for the same tasks. A fundamental difference exists in how we normally communicate and how we communicate with computers. Normally, most human communication consists of intertwined input/output, where it is very difficult to separate the two. Often, the same medium is used for both, as in the case of a book, where the printed text represents the output, and annotations written in the margins represents the additional input of the reader. Normal conversation consists of gestures, glances, as well as the spoken word. All are used to convey the richness and the density of the information being communicated.

The computer has separated input from output. The display or screen is used by the computer to show output to the user, while the keyboard or another input device is used by the user to input information into the computer. We use our eyes to read the screen while using our hands to input information. This separation of input and output is a step back from previous forms of communication. The great potential of the connection of the human brain and the electronic brain is severely handicapped by our present approach to input/output.

The Age of Look and Feel. Today, the majority of efforts in the human-computer interaction field is concerned with the "look and feel" of computers and their applications. According to Bill Buxton, this only addresses one third of the problem. He breaks the area of human-computer interaction into three sub-areas:

1. How does the system reflect the human motor/sensory system? This is the issue of look and feel.
2. How does the system reflect the human cognitive or problem-solving mechanisms? In other words, does the system reflect how people think and make decisions?
3. How does the system reflect the sociopolitical structure of day-to-day life? Does the technology reflect or support the concept of work performed in groups?

For a user interface to be effective its design must address all three areas. Yet, most of the effort is concentrated on look and feel issues, with much of the emphasis on the "look" of technology. (Buxton 1990 205-206)

Where Are We Going?

The Reconnection of Input and Output. Today, a new interface device is being developed. The first primitive forms of paper-like interfaces attempt to recombine input and output by allowing the user to input information on the same device used by the computer to display output. Touch displays, and pen/stylus interfaces are early versions of the computers of tomorrow. Portable computers will be the first computers to take advantage of the combined input/output interface. Another possible use is the concept of glass desktops, where the display is actually the desktop (large LCD or gas plasma displays provide the best solution today, as both are relatively thin, and generate little heat).

The glass desktop would be a natural extension of a common interface of today, the graphical user interface or GUI. The GUI is an attempt to make computers more intuitive by using familiar "everyday" analogies for computer operations. The concept of the on screen desktop or office is used by many current GUIs, providing file folders, waste cans and other familiar office items. The glass desktop would provide an extension to the desktop GUI of today by becoming an integral part of the office of tomorrow. The same is true for small, lightweight, highly portable computers.

One question currently being pondered is what happens to one way devices, such as the keyboard, in such systems? The keyboard is an effective input device, but if it can be eliminated, both weight and space can be recovered. Handwriting recognition is the currently discussed replacement for the keyboard, but it has one major drawback: speed of input. A good touch typist can reach speeds of up to one hundred words a minute, far faster than the speed one can write at. Perhaps handwriting recognition is not the solution, a different form of recognition might prove more effective. Stenographers can use shorthand to write 200 plus words a minute. A system that provides shorthand recognition might prove to be a system that does not require a keyboard. While a skill would have to be learned, the benefits may make the effort worthwhile. Voice input is another possibility, as we can talk far faster than we can write or type. Voice input does have potential drawbacks: such as use in a crowded room or shared office. How would one direct voice input to the computer while talking with someone else? This problem is solvable, one approach would be to have the computer respond only when its "name" is spoken.

In the last several years the concept of direct manipulation for human-computer interaction has received a great deal of interest and enthusiasm. The central ideas of direct manipulation are:

- Objects and actions on the objects of interest are clearly visible
- Actions are incremental and reversible
- Complex command languages are replaced by the ability to directly manipulate the object of interest.

A good example of direct manipulation is driving an automobile. The scene is visible through the windows. Actions such as steering or braking or accomplished by "manipulating" a brake pedal or the steering wheel. Any action can be reversed quickly and easily (lifting the foot off the accelerator, turning the steering wheel the opposite direction). Response to all actions is immediate, and feedback is provided by changes in the view through the windows. (Shneiderman 180)

Video games are another example of direct manipulation systems. The environment of the game provides an abstract of reality. All learning is by analogy. Commands are physical actions, such as pressing a button, moving a joystick with the results shown immediately on the screen. There is no syntax and, more importantly, no error messages. Error messages are unnecessary as the results of actions are shown immediately, providing the user the opportunity to make compensating adjustments. Such aspects of direct manipulation can be applied to educational software.

Direct manipulation is an attempt to make the power of the computer available to a larger audience. The Swiss psychologist Jean Piaget once described four stages of growth:

- Sensorimotor (from birth to approximately four years)
- Preoperational (two to seven years)
- Concrete Operational (seven to eleven years)
- Formal Operations (begins approximately eleven years)

Direct manipulation attempts to bring activity to the concrete operational stage. (Shneiderman 203)

Direct manipulation may provide an environment beneficial for the development of problem solving skills. Video games present a problem (how do I get to the next level, where are the bonus prizes) by creating an environment in which the user, by interacting with the game, begins to develop a strategy. The same is true for all direct manipulation systems. As the user interacts with a direct manipulation system, the feedback from the system is used to develop a successful strategy. Research in the problem-solving psychology literature has shown that suitable representations of problems are critical the development of problem solving skills. (Shneiderman 198)

The key aspect of direct manipulation is that it is an approach relatively independent of interface devices. A well designed text editor has elements of direct manipulation. Text is entered and edited via the keyboard. The results of interaction is immediately seen, and adjustments can be quickly made. The cursor is used to select the object of interest, and the user directly changes the object by entering information via the keyboard. Direct manipulation, and its benefits, can be applied to any application.

By combining direct manipulation with new technologies leaps in the effectiveness of the user interface may be realized.

Two relatively new developments in the human-computer interaction field look to have great potential for the educational technology field. Multimedia represents the collection of text, graphics, images, full motion video and sound in a cohesive collection that can be studied, interacted with and explored (Wright 90). Multimedia documents can be created that offer great educational possibilities by providing a rich sensory environment for exploring information. Virtual reality, the concept of where the user is enveloped in a world created by the computer (Wright 91) is perhaps the first human-computer interface that truly reconnects input and output. Virtual reality carries the concepts of direct manipulation to a new level, as the interface device is the user. Virtual reality offers many possibilities in the area of educational technology by allowing the student to become an active part of the lesson.

Adaptation. Today, the quality of human-computer interaction is at a primitive level. Today, the user must adapt to the computer. According to Shneiderman "computers are available only to people who devote extensive effort to mastering the technology. (Shneiderman 4) For many adult users, this is at most a frustration. However, for users with physical disabilities or those whose physical abilities are not fully developed (such as younger children) the limitations imposed by current computer technology and their interfaces can be very frustrating. In some instances, these limitations can make the difference between being able to use the computer or not. Various adaptive devices are available, but rarely does commercial software support interface devices beyond the conventional mouse/keyboard/display combination.

As computers are used by a greater range or people, understanding the physical, intellectual and personality differences among users is vital. (Shneiderman 19) According to Buxton what is required is transparent access to standard applications. The concept of transparent access is the ability of standard commercial applications to support any form of interface simply by plugging the interface device into the computer. This would be done without any changes to the existing applications. (Buxton 1991 2.13) Transparent access to applications would allow the user to select the interface device best suited to the individual.

Another level of transparency is related to the user interface. The more transparent the user interface the more the user is able to apply their knowledge directly to the task. When the user interface seems to disappear, the user is able to concentrate solely on the task. That is the paradox of the user interface. The best interface is the one that no one sees. When that occurs the user interface is no longer a filter or intermediary between the user and the computer, it is an aid that enhanced the communication between the human and the computer.

Human/Computer Interaction Guidelines or Suggestions

The following guidelines were developed by the author over the last several years and represent the experiences of the author and other software developers as well as current literature in the human/computer interaction field. The guidelines should not be viewed as an exhaustive or complete set of guidelines, but as suggestions, and recommendations.

The best interface is one that neither hampers nor impedes one's progress.

Remember the paradox of the user interface: the best interface is the one that no one sees.

Never blame the user, blame the user interface: if your audience is having difficulty in understanding how to use your application, don't blame them. Ask them what's confusing, and make changes in the user interface that get rid of the confusion.

Follow the principles of direct manipulation:

- All objects should be clearly visible,
- Interaction should be expressed as physical actions (pressing a button, touching a control, pulling down a drop down menu) instead of through complex syntax,
- Results of actions on objects should be immediately obvious (visible) and actions should be incremental (building on past actions) and reversible.

Before developing the system, understand what the real goals of the system are; e.g. in the case of an educational system, what do you want the student to learn?

Be sure that the user interface does not interfere with the intended goals of the system. In the case of an educational system, be sure the user interface does not interfere with the learning experience.

Ask yourself the question "Does the user interface shift the focus of the user away from the intention of the design?" Again, in the case of educational software, does the user interface actually cause the use to learn something different from what is intended? Does the user interface shift the attention of the user from the desired learning experience to a different one? Simply put, does your interface teach the student a meaningful experience or does it teach how to use the cursor keys?

Understand the physical skills of your intended audience. If your audience is preschoolers, realize that they may not have the fine motor ability to use cursor keys to move between objects. A touch screen would be more effective in this case.

Design for the lowest common denominator of user. The idea is to design the user interface such that it can be used effectively by the largest possible range of people. Consider direct manipulation and how it attempts to bring the power of the computer to a larger audience.

What's good for the goose is often good for the gander. This may seem contradictory to the previous suggestion, but this suggestion focuses on commonality. Realize that while portions of your audience have characteristics unique to themselves, they also have characteristics that are true for the entire audience. As an example: from personal experience the author has the theory that there is little difference between a 4 year old novice computer user and a 40 year old novice computer user. The major difference is that the 4 year old has absolutely no fear of the computer while the 40 year old may experience some fear of the computer. What they have in common is that are computer novices, and they will use models of interaction that have been successful for them in the past. The most effective interface for one may be surprisingly effective for the other.

Avoid "dead zones." A "dead zone" is an area of the user interface that when accessed no feedback is given. Consider an interface in which only 6 keys of the keyboard are active, pressing any other key causes nothing to happen. This is, at best, frustrating. At the very least, provide feedback to the user that the "dead zone" does not cause anything to happen and point the user to the active areas of the interface.

In contrast to "dead zones," support exploration of your interface by the user. Do this by providing occasional surprises when certain action sequences are made. People, especially children, like to explore, so reward them for their curiosity. "Dead zones" punish curiosity by providing no, negative or inappropriate feedback.

Understand the design approach of a good video game, and see if you can "imitate" in your application some of the effective characteristics of video games:

- No error messages—use immediate feedback to show the user the result of their actions, allow them to adjust their "position."
- Use multiple types of rewards to motivate:
- Progressive rewards to motivate the user to improve their skill. Video games provide multiple, progressively harder to reach levels to motivate the player to improve their game skill.
- Surprises to motivate the user to explore for more information. Video games use the concept of hidden treasure or passageways to motivate the player to explore the environment.

The number of possible actions should be roughly equal to the number of controls. When the number of actions is greater than the number of physical controls confusion can occur. Modern telephones with phone mail capability is a good example, a great amount of function, but hard to use because the number of controls is less than the number of functions. When the number of possible actions is less than the number of controls frustration can occur. The controls that have no associated action are "dead zones," using them causes no visible action or feedback.

Consider writing the user documentation before developing the application. Once the user documentation is complete develop the application so it works exactly as documented.

Be empathetic of the intended audience for your application. When possible take advantage of the intelligence and experience of the user. Understand the work environment of the user. My favorite example of applications that don't follow this guideline are CAD programs. An ideal tool for the draftsmen would be an intelligent sketch pad, one that an experienced draftsman could walk up to and use immediately, because it was built on the same concepts that a draftsman learns as part of his trade. What we have are applications that force the draftsmen to relearn their skill, to take a different approach to their work, because of the limitations of the user interface.

References

Buxton, Bill. The Pragmatics of Haptic Input. unpublished manuscript, 1991.

Buxton, Bill. "Smoke and mirrors." Byte, July 1990, pp.205-210.

Norman, Donald. The Psychology of Everyday Things. New York NY: Basic Books, Inc., 1988.

Shneiderman, Ben. Strategies for Effective Human-Computer Interaction. Reading MA: Addison Wesley Publishing Company, Inc., 1987.

Wright, Karen. "The Road to the Global Village." Scientific American, March 1990. pp.84-94.

Barron, Janet J. "The Wizards of the Media Lab." Byte, December 1989, pp.353-360.

Ditlea, Steve. "Inside Artificial Reality." PC/Computing, November 1989. pp.91-102.

Nelson, Ted. Computer Lib / Dream Machines. Redmond, Washington: Tempus Books of Microsoft Press. 1987.

Nelson, Ted. Literary Machines 89.1. Sausalito, California: Mindful Press. 1990.

Saffo, Paul. "The Paper Revolution." Personal Computing, July 1987. pp.43-45.

Saffo, Paul. "Virtual Reality Is Almost Real." Personal Computing, June 29, 1990. pp.99-102.

Tufte, Edward R. The Visual Display of Quantitative Information, Cheshire, Connecticut: Graphics Press, 1983.

Paper (M3.8c)

The Novice Model in a Modern Algebra Intelligent Tutoring System

Constance M. Conner and Barbara A. LiSanti
Mills College
San Francisco, California

Abstract

While Computer Aided Instruction (CAI) can be considered a mature technology, Intelligent Tutoring Systems (ITSs) are still an infant technology. Such systems differ from other software approaches to education by their attempt to provide effective instruction in problem solving the way a human tutor does. One ITS under current development is the Modern Algebra Tutor (MAT). The goal of MAT is to develop a computer based tutor that is as effective in teaching introductory Modern Algebra as a human tutor.

The Novice Model, and how best to represent the student within an ITS, is the focus of this paper. Three sets of issues regarding the design of the Novice Model are addressed. The first issue addressed is a task-analysis of the domain of Modern Algebra and its associated proof construction techniques. This is necessary in order to chose an appropriate knowledge representation of the domain.

The second set of issues addressed by the paper are the different cognitive theories of student modeling and the role they play in the development of ITSs. The student model theories drive the design choices for the MAT project's Novice Model.

This theoretical background motivates the final set of issues: The "real world" implementation considerations and decisions that determine how to translate Modern Algebra concepts into efficient software data structures. These data structures must correspond to each novices' knowledge base in order to provide individualized instruction. The details of MAT's Novice Model specifications and implementation are discussed within this background.

Introduction

While Computer Aided Instruction (CAI) can be considered a mature technology, Intelligent Tutoring Systems (ITSs) are still an infant technology. Such systems differ from other software approaches to education by their attempt to provide effective instruction in problem solving the way a human tutor does. One ITS under current development is the Modern Algebra Tutor (MAT). The goal of MAT is to develop a computer based tutor that is as effective in teaching introductory Modern Algebra as a human tutor.

MAT, and an ITS in general, is composed of four basic modules: A User Interface, an Expertise Module, a Teaching Module, and a Novice Model (sometimes referred to as a Student Model). (See Figure 1 for a graphical representation of MAT.) The User Interface communicates directly with the student. The Expertise Module is the "domain expert" that can actually solve the problems. The Teaching Module is a set of specifications of how the system should present materials to the student and controls the actions of the other basic components.

The fourth component of MAT, the Novice Model, interacts with the Teaching Module to provide information regarding the novice's knowledge state. This is the system's current understanding of the history, capabilities, knowledge, goals, and misconceptions of the "typical" novice as well as the novice currently using the system. This information is stored in the INPDF, the Individual Novice's Permanent Data File, and is used by the Novice Model to help the Teaching Module provide optimal tutoring sessions with individual students.

The Novice Model, and how best to represent the student within an ITS, is the focus of this paper. Three sets of issues regarding the design of the Novice Model will be addressed. First, to place MAT's Novice Model in context, it is important to understand the central component of any ITS: The Expertise Module. Of primary concern will be a task-analysis of the domain of Modern Algebra and its associated proof construction techniques in order to choose an appropriate knowledge representation of the domain. As knowledge transfer is the raison d'etre of the project, the representation of this knowledge is of primary importance.

The second set of issues to be addressed by the paper is the different cognitive theories of student modeling and the role they play in the development of ITSs. Different student model theories and how they might be applied to the domain of Modern Algebra are considered. The student model theories drive the design choices of the MAT project's Novice Model.

This theoretical background will motivate the final set of issues to be addressed: The "real world" implementation considerations and decisions that determine how to translate Modern Algebra concepts into efficient software data structures. These data structures must correspond to each novice's knowledge base in order to provide individualized instruction. The details of MAT's Novice Model specifications and implementation are discussed within this background.

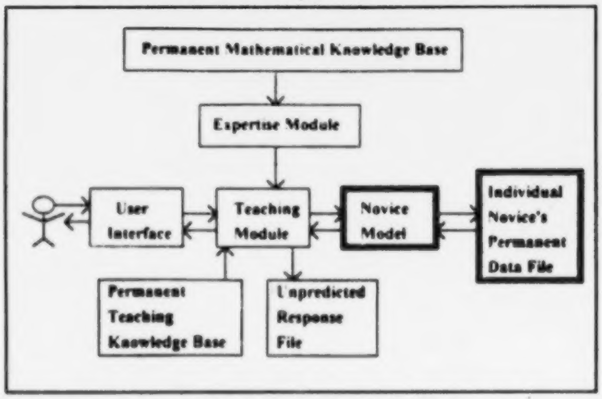

Permanent Mathematical Knowledge Base
Expertise Module
User Interface
Teaching Module
Novice Model
Individual Novice's Permanent Data File
Permanent Teaching Knowledge Base
Unpredicted Response File

Figure 1. Modern Algebra Tutor System Overview

Background: Modern Algebra Knowledge Representation

Before the Novice Model can be implemented, the domain content that forms the knowledge base of Modern Algebra must be analyzed. As the goal of MAT is to transmit the knowledge embedded in the Expertise Module, as well as the representation of that knowledge, this analysis forms the foundation of the system.

The domain of Modern Algebra is ideally represented by what Gagne (1970) refers to as a "prerequisite hierarchy." The domain is made up of two basic kinds of knowledge units: 1) Declarative knowledge or facts (e.g., *Definition of a Group*); and, 2) procedural knowledge, the knowledge of how to do things (e.g., *How to prove that a Subset of a Group is in fact a Subgroup*). These knowledge units can be decomposed into component concepts or prerequisites, e.g., A and B are prerequisites for C.

The tree illustrated in Figure 2 was based on a protocol analysis done by Dr. LiSanti of students learning to solve a problem in the Modern Algebra textbook by Fraleigh (1989). That problem requires the student to prove th*at a Specified Subset of a Group is in fact a Subgroup.* This analysis allowed the writers to establish a hierarchy of concepts that closely followed the ordering of concept presentation in the text of Fraleigh. The individual concepts and their interconnecting structure form what Artificial Intelligence (AI) researchers call a "semantic network" or "graph" of the relations. Because the domain is not truly linear in its prerequisites, it was necessary to structure the concepts as a graph to show that at some levels concepts are learned in conjunction with one another. These "sibling" concepts then are grouped to become the prerequisites or ancestors for their "children" concepts. This graph of concepts was used as the foundation for developing the Individual Novice's Permanent Data File (INPDF), and will be discussed in more detail later in this paper.

Theory: Modeling The Student

The student model is a method of representing the student's understanding of the material to be taught. The Novice Model is used to make hypotheses about the student's misconceptions and suboptimal performance strategies so that the system can point them out, indicate why they are wrong, and suggest corrections. What the Novice Model should provide the tutoring system is fairly straightforward, how the student should be modeled is less clear-cut. Approaches to modeling student knowledge in Intelligent Tutoring Systems tend to fall into two theoretical camps: Those who view the student's knowledge state as subset of a complete model of expertise, the "ideal" student; versus those who view the student as a catalogue of internalized misconceptions and errors, the "buggy" student.

The structure of MAT's Expert Module was a significant factor in determining the theory of student modeling that should be implemented. MAT's Expertise Module is responsible for constructing the Modern Algebra proofs and can be thought of as the "ideal" student. The Novice Model, therefore, does not need to construct the proofs presented. Instead, the Novice Model needs to guide the Teaching Module in sequencing the subject matter. This guidance needs to be adaptive, for each student, and dynamic, while instruction is happening.

The "buggy" version of the student would be very difficult to build for the subject of Modern Algebra. In the DEBUGGY program (Burton, 1982), which was teaching simple subtraction, 10 primitive bugs grouped with 58 subskills were enumerated. In Anderson's program for tutoring LISP, 325 rules and 475 buggy rules were enumerated (Anderson & Reiser, 1985). As Modern Algebra is a more advanced form of mathematics, the writers concluded that the number of errors that could occur would be of a much greater magnitude and enumerating all of them would be beyond the scope of the project at this time.

Instead, the MAT Novice Model uses the theory of the "overlay" student model that was first proposed in Carbonell's (1970) SCHOLAR project and later expanded in Clancey's (1979) GUIDON and Carr and Goldstein's (1982) WUSOR projects. The student can be represented by the set of subject matter units mastered, in this case the Modern Algebra concepts the student knows how to apply. Each student is represented in MAT's Individual Novice Permanent Data File (INPDF) as a network of tick-marks which, as it were, is laid over the representation of the domain of Modern Algebra to show which concepts the student has already mastered. As discussed by Ohlsson (1987),

> From the overlay point of view, the student knows a subset of what a domain expert knows. Learning is the process of acquiring a progressively more complete subset of the expert's knowledge units, but different learners can acquire those units in different orders, so that two learners who have roughly the same amount of knowledge can, nevertheless, know very different things. (p. 207)

Although a "buggy" student model was not chosen, the ability to handle misconceptions was built into the Novice

Model. Certain record keeping fields of MAT's INPDF will allow the Teaching Module, in conjunction with the Novice Model, to do some bug diagnoses (see discussion of implementation details below). Burton and Brown (1979), suggest having the student model program make a note every time it has evidence of the student acquiring a required skill. This type of model is useful in formulating feedback; particularly in distinguishing careless mistakes or "slips" (in skills the student has mastered) from real misconceptions (in skills the student is working to acquire).

While no tutor can read a student's mind, this version of a student model will allow MAT's Tutoring Module to make inferences regarding the cognitive state of the student. The tutor will be able to assess not only how much a student knows, but *what* a student knows. Because the Novice Model dynamically updates the INPDF, instant diagnoses of the student's needs can be delivered to the Teaching Module. This will allow MAT to deliver an individually tailored instructional plan to each student.

Implementation: MAT's Novice Model

After choosing the overlay theory of student modeling as the paradigm to be implemented as MAT's Novice Model, the knowledge representation of the list of concept specific plans must be turned into executable computer code in order to have any "real world" usefulness. Park's (1988) definition of the overlay student model is useful to keep in mind:

> The student model consists of three subcomponents: (a) The student knowledge base and performance history, (b) learning deficiencies and learning needs catalogues, and (c) a data base of individual difference variables. (p. 8)

These criteria were expanded by Dr. LiSanti to a list of seven specifications that are necessary to create a working novice model. How these specifications were implemented in the MAT project, and how they form the "overlay" of the student is discussed below.

MAT was implemented on a NeXT workstation using the Objective C object-oriented language. Figure 3, the "Concept Inspector", or visual interface to the INPDF, is a concrete representation of an individual concept. Each concept has associated fields and switches that are the tick-marks discussed by Ohlsson (1987). Each concept also has a list of related concepts, both ancestors and siblings (the "Lower Concepts" panel in Figure 3), that represent the graph of the partial domain of Modern Algebra (Figure 2). The concepts, when grouped together in an ordered list, form the overlay of the student model.

1. *A list of concept-specific plans whose use the novice has mastered.* As implemented, the concept-specific plans are the basis of the Individual Novice's Permanent Data File. Each concept can be thought of as its own object (in Figure 3 the concept shown is *Group*). These concept objects when grouped form a list of concepts. (Fortunately, in Objective C there is an object that handles ordered groups of objects that is literally called a List. This coincidence makes the rest of the implementation explanation much easier.) In addition, each concept is linked to its ancestor and sibling concepts ("Lower Concepts" panel, Figure 3). It is this linked list that corresponds to the semantic net or graph of concepts represented in Figure 2.
2. *A list of concept-specific plans whose use the novice has attempted to master, but has failed in the attempt.* In the Novice Model, lists of unsuccessful, not mastered, concepts are only created upon request. When an individual concept's "Success" switch is not set, or at any other time the Teaching Module may need the information, the Novice Model can create a list of unsuccessful lower concepts associated with any given concept. The first unsuccessful concept in the list will be the concept currently being taught; a recursive function is then called to search that concept's "List of Lower Concepts". For each unsuccessful lower concept encountered, an addition is made into a "List of Unsuccessful Lower Concepts", and this is then passed to the Tutoring Module for further diagnosis. As an example, if a student has not successfully mastered any of Group's lower concepts, the Novice Model would provide the Teaching Module with the following list: *Group; Set; Associative; Identity; Inverse*. The Teaching Module can use this list to direct the teaching strategy for that student.
3. *A list of proofs successfully completed by the novice.* Associated with each concept are three problems, most of which are proofs, that have as their key a field to hold the problem's "name". For the concept G*roup* the three associated problems are: *Order of Group Axioms; Inverse of Triple Product;* and *Existence of Solution*. These problems, in themselves, contain a field that records the number of times the student has attempted the problem ("Attempts" field), as well as a field that shows whether mastery has been achieved ("Success" switch).
4. A *list of proofs partially completed by the novice and for each such proof a list of lowest level sub-goals that the novice has established.* Each problem/proof has an associated array, or checklist, of up to ten sub-goals. The Tutoring Module can use this array to track which subgoals have been mastered. For example: To achieve "Success" for Problem 1, Ord*er of Group Axioms* (Figure 3), there are six possible orderings that first must be identified and then, one by one, verified or eliminated. This is another example of how the Novice Model tracks the level of skills the student acquires over time.
5. A *list of diagnosed misconceptions revealed by the actions of the novice and for each misconception the context in which it was diagnosed.* Like the structure of problem lists, lists of misconceptions are associated with individual concepts. Each concept has up to three associated misconceptions, or bugs, that can be used individually or

in combination. Associated with each bug is an "Encountered" field that keeps a running total of times the misconception was exhibited, and a "Resolved" switch that is set when the student has unlearned the misconception. The context in which the bug was last diagnosed is determined by the "Context" field. If the "Resolved" switch for a particular bug is set, and the student later encounters the same bug, the Novice Model will diagnose this as a "slip" or a careless mistake.

6. *A list of unpredicted responses and the context in which each response occurred.* This is the only specification not currently implemented. The writers assume this will be a separate file containing bug responses that the system could not handle. The Teaching Module could be responsible for opening and maintaining this file.
7. *The instructor's specifications regarding semi-passive versus active mode and the level of assistance to be supplied to the novice.* This is the "level" field and "Active/Semi-Passive" switch in each concept object. These two fields are used to determine the amount of coaching the student receives. Because MAT will be a "learning by doing" system, with students generating proofs on their own in the Teaching and Review Modules, appropriate coaching will be given. The coaching can take the form of hints, cues or corrections. How much, and what form, the coaching takes is dependent on the level of assistance determined by the tutor. This in turn can be used by the Tutoring Module to determine the kind and amount of remedial instruction given. The instructor specifies this field within each concept object by manually assigning a value to the field.

When taken together the INPDF and the Novice Model contain the three subcomponents discussed by Park above. The student knowledge base and performance history represent the student's most recent performance and mastery level. The learning deficiencies and learning needs "bug" fields represent the student's misconceptions and suboptimal performance strategies that may have been used to construct proofs. These components form a data base containing the student's important individual differences. When combined with the diagnostic capabilities of the Teaching Module, the tutor is able to infer certain things about the current cognitive state of the student as she attempts to learn Modern Algebra proof construction.

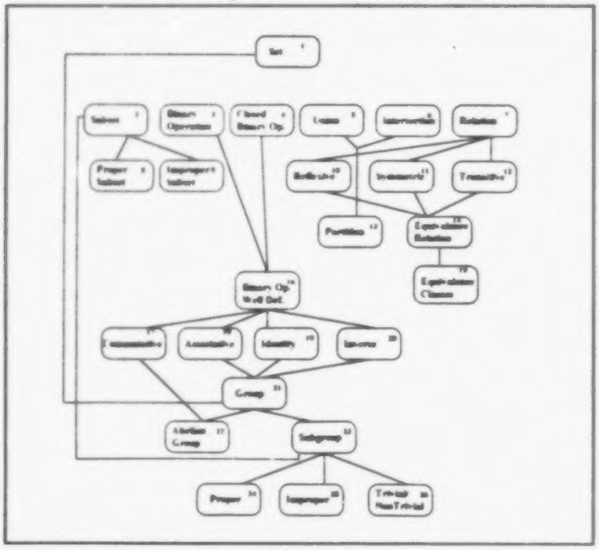


Figure 2. Concept Hierarchy

Conclusion

At this time the Novice Model is the only component fully implemented for the MAT project. The object-oriented paradigm allowed the Novice Model to be built independently of the rest of MAT's modules. Although the Teaching Module is currently under development, the interface between it and the Novice Model has been thoroughly tested. The Novice Model is able to respond to all messages requesting information concerning the state of the student's current knowledge; as well as diagnosing some aspects of the student's performance. The Novice Model implements aspects of both the "overlay" and "buggy" theoretical models of the student. This allows the MAT project to support an individualized instruction teaching strategy.

References

Anderson, J. R., & Reiser, B. J. (1985). The LISP TUTOR. Byte, *10*(4), 159-175.

Burton, R. R., and Brown, J. S. (1979). An investigation of computer coaching for informal learning activities. *International Journal of Man Machine Studies, 11*, 5-24. Reprinted in D. H. Sleeman & J. S. Brown (Eds.), *Intelligent Tutoring Systems* (pp. 79-98). London: Academic Press.

Burton, R. R. (1982). Diagnosing bugs in a simple procedural skill. In D. H. Sleeman & J. S. Brown (Eds.), *Intelligent Tutoring Systems* (pp. 157-185). London: Academic Press.

Carbonell, J. R. (1970). AI in CAI: An artificial intelligence approach to computer-assisted instruction. *IEEE Transactions on Man-Machine Systems, 111*(4), 190-202.

Clancey, W. J. (1979). Tutorial rules for guiding a case method dialogue. *International ournal of Man Machine Studies, 11*, 25-49. Reprinted in D. H. Sleeman & J. S.

Brown (Eds.), *Intelligent Tutoring Systems* (pp. 201-223). London: Academic Press.

Fraleigh, J. (1989). *A First Course in Abstract Algebra.* Reading, MA: Addison-Wesley.

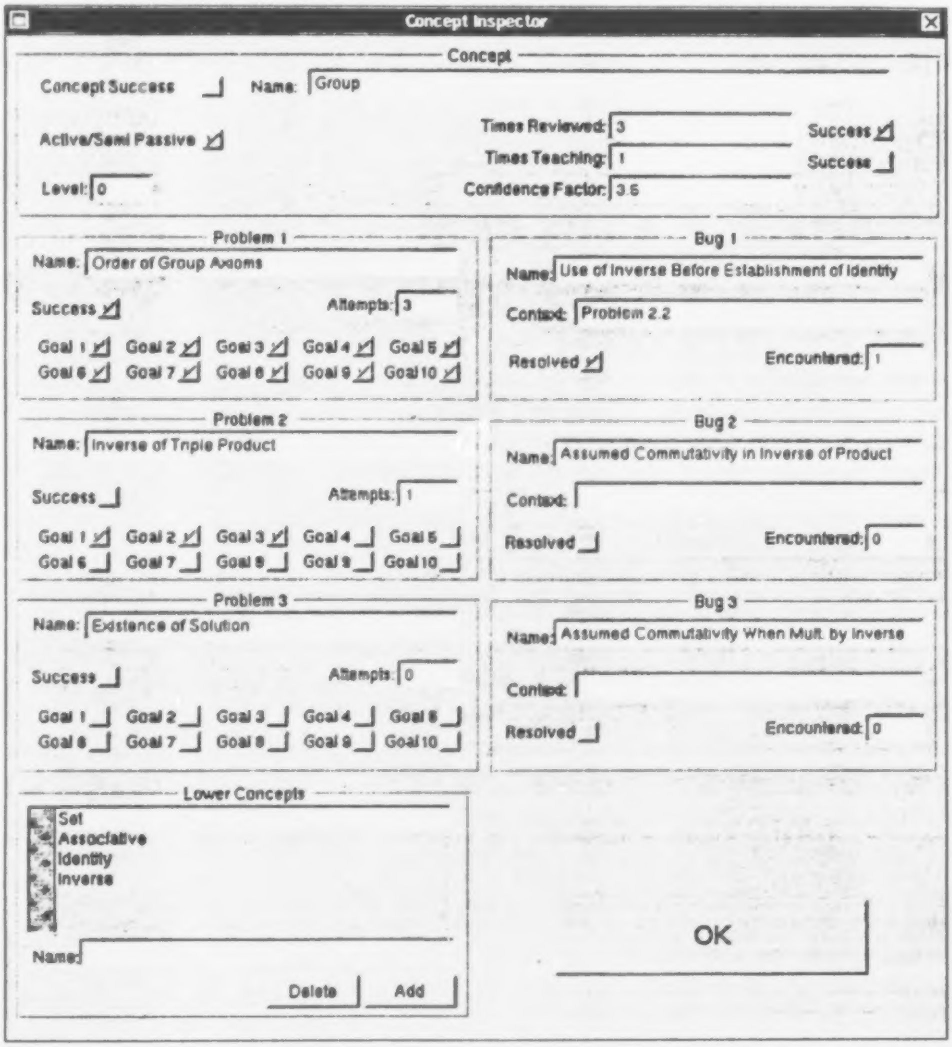
Goldstein, I. P. (1982). In A. Barr and E. A. Feigenbaum (Eds.), *Handbook of Artificial Intelligence* (vol. 2). Reading, MA: Addison-Wesley.

Ohlsson, S. (1987). Some principles of intelligent tutoring. In R. Lawler and M. Yazdani (Eds.), *Artificial Intelligence and Education: Learning Environments and Tutoring Systems* (pp. 203-237). Norwood, NJ: Ablex.

BEST COPY AVAILABLE

Park, O. (1988). Functional Characteristics of Intelligent Computer-Assisted Instruction: Intelligent Features. *Educational Technology*, 27(6), 7-13.

Wenger, E. (1987). *Artificial Intelligence and Tutoring Systems: Computational and Cognitive Approaches to the Communication of Knowledge.* Los Altos, CA: Morgan Kaufmann.



Concept

Concept Success ☐ Name: Group

Active/Semi Passive ☑

Times Reviewed: 3 Success ☑

Times Teaching: 1 Success ☐

Level: 0

Confidence Factor: 3.5

Problem 1

Name: Order of Group Axioms

Success ☑ Attempts: 3

Goal 1 ☑ Goal 2 ☑ Goal 3 ☑ Goal 4 ☑ Goal 5 ☑

Goal 6 ☑ Goal 7 ☑ Goal 8 ☑ Goal 9 ☑ Goal 10 ☑

Bug 1

Name: Use of Inverse Before Establishment of Identity

Context: Problem 2.2

Resolved ☑ Encountered: 1

Problem 2

Name: Inverse of Triple Product

Success ☐ Attempts: 1

Goal 1 ☑ Goal 2 ☑ Goal 3 ☑ Goal 4 ☐ Goal 5 ☐

Goal 6 ☐ Goal 7 ☐ Goal 8 ☐ Goal 9 ☐ Goal 10 ☐

Bug 2

Name: Assumed Commutativity in Inverse of Product

Context:

Resolved ☐ Encountered: 0

Problem 3

Name: Existence of Solution

Success ☐ Attempts: 0

Goal 1 ☐ Goal 2 ☐ Goal 3 ☐ Goal 4 ☐ Goal 5 ☐

Goal 6 ☐ Goal 7 ☐ Goal 8 ☐ Goal 9 ☐ Goal 10 ☐

Bug 3

Name: Assumed Commutativity When Mult. by Inverse

Context:

Resolved ☐ Encountered: 0

Lower Concepts

Set
Associative
Identity
Inverse

Name:

Figure 3. Concept Inspector

BEST COPY AVAILABLE

Projects (M3.9)
Teacher Training & Instructional Applications

Learning About ILSs: What Has Research Shown?

Ken Brumbaugh and James L. Poirot
Texas Center for Educational Technology
University of North Texas
Denton, TX

Abstract

During the 1990-92 period, the Texas Center for Educational Technology (TCET) has conducted a variety of research and development projects related to learning more about the use of Integrated Learning Systems. This session will highlight several of the public-private collaborative efforts, which were supported by several different ILS companies. Research efforts to be discussed include: creating a set of instruments for use in preparing to use ILSs, evaluating the effective of ILSs in special learning situations, identifying learner characteristics of successful ILS students, and creating a general planning guide for decision makers who might be considering the use, or greater use, of ILSs. Results that have been shared with Texas educators will be available for preview and discussion.

"Kids" CAMP: Computer Animation Macintosh Project

Chris Carey and Jan Blau
Edgewater High School
Orlando, FL

Abstract

Economically disadvantaged students at Robert E. Lee Middle and Edgewater High School, Orlando, Florida have an opportunity to explore Computer Animation, a career that would not normally be available to them. The Computer Animation Macintosh Project (CAMP) is funded through a Crossroads II grant from Apple Computer, Inc., a Business Partnerships grant from the state of Florida, a grant from the Edgewater High School Foundation, Inc., and a Christa McAuliffe Fellowship award. Funding for this program thus far exceeds $250,000. Students in the eighth grade who are potential dropouts and have an interest in computers and drawing are targeted at the middle school level in the hope that these students will continue their education instead of dropping out of school. Students learn basic drawing and animation skills, storyboarding, and product creation. They also create visual product portfolios they can use when applying for jobs or college entrance. The students emerge from this program with computer graphic skills enabling them to seek entry level jobs in the work force. Come and learn how the program began and the progress that has been made thus far during the program's second year in operation.

Managing the Mid-Life Crisis: New Directions in Instructional Computing

Sandra Etheridge and Joseph Howell
Gulf Coast Community College
Panama City, FL

Abstract

The community college movement has begun to experience the tell-tale signs of mid-life crisis: the sense of stagnation, the need for renewal and reaffirmation, the challenge of recommitment to positive contribution in the future. With their roots in the mid-1950's, many community and junior colleges are now approaching the end of their fourth decade. Rapid structural growth and curriculum expansion came in the 1960's as did a wave of new faculty members. In some instances, this particular group still constitutes the bulk of the faculty. But as these faculty members approach retirement eligibility, community colleges are being faced with a twin dilemma: (1) how to integrate new methods and technologies into the entrenched teaching styles of a mature faculty, and (2) how to best anticipate the rapid changes which are sure to follow mass faculty turnover in the near future.

At Gulf Coast Community College, these challenges are being addressed by a Faculty Development Project begun nearly four years ago which is designed to quickly move faculty members from simple computer literacy to aggressive in-class and laboratory academic computing. This presentation will tell the story of GCCC's "revisioning" of its instructional goals and methods.

A Mathematics Computer Lab from Concept to Completion

Paige A. Lado
Gainesville High School
Gainesville, FL

Abstract

Project IMPACT (Increasing Mathematics Potential through Access to a Curriculum Enriched by Technology) is an innovative attempt to increase the mathematics potential of high school students by granting them access to a state of the art computer lab equipped with a spectrum of mathematics software and multimedia equipment as well as equipping teachers with the latest technology to enable them to present the traditional curriculum in new and exciting ways.

This presentation reviews the project from conception to implementation including the following: goals, writing the grant proposal, teacher involvement and decision making, evaluation and purchase of equipment and software, teacher training and staff development, set up and implementation of the project, methods of evaluation, and future plans.

Project IMPACT is funded by a State of Florida Innovative Technology Grant and is located at Gainesville High School in Gainesville, Florida. Project IMPACT is a non commercial venture.

Projects (M3.10)
Multimedia

Connecting Students and the Community Through Hypermedia

Larry Adamson and Ty Pelfrey
Live Oak Middle School
Live Oak, CA

Abstract

Students are literally converting their town into hyperstacks. They have assembled a Multimedia Demographic Database and with the help of their community are creating a product comparable to a computerized Foxfire.

Communicating in Public: Native American Students Develop Multimedia Museum Displays

Doreen Bailey and Dan Ferguson
Santa Fe Indian School
Santa Fe, NM

Abstract

The main purpose of the collaboration between Santa Fe Indian School and the Bureau of Land Management that resulted in the Hupobi Heritage museum display was to involve Pueblo Indian youth in interpreting their cultural heritage for non-Native Americans, while providing the students with technical training and enriched educational opportunities. The main outcome: students from the Santa Fe Indian School created an interactive, multimedia display for the new Gateway to the Past Museum at the Ghost Ranch Living Museum, a New Mexico location that attracts over 100,000 visitors a year.

The computer exhibit celebrates the architecture, agriculture, technology and history of Hupobi, an old Pueblo town located north of present-day Ojo Caliente, NM. Hupobi, and other ruins along the Rio Ojo Caliente, are ancestral to the students' home community, San Juan Pueblo. For the exhibit, the students interviewed Pueblo elders and artisans, archaeologists and anthropologists, researched topics at the Laboratory of Anthropology collection, the New Mexico Historical Archives and the School for American Research, and used our own strong Indian Collection at the Santa Fe Indian School Library Media Center to gather information. After the research specialists and the student interns completed the research, they storyboarded the production and developed a pictorial flowchart showing both screens and paths. Collected images were scanned and refined. The students digitized, edited, and compiled video sequences and audio narration. Under the guidance of computer specialists, students imported QuickTime, pictorial and sound elements in MacroMedia Director 3.1 and scored each section. Beyond the computer skills the students acquired, they also received exposure to potential careers in photography, videography, history, archaeology, anthropology, museology and resource management. Most importantly, they gained renewed respect for their cultural heritage, which has maintained its way of life in Northern New Mexico for over 2,000 years.

The project was evaluated by three instruments, reflecting the viewpoints of the students, educators and clients. These evaluative instruments and results are available upon request, but a more meaningful summation on the value of the project might be the comment of one of the student participants: "I am very proud of the project. It is better than the others I saw and it is something that **everyone** can see."

Hurricane Andrew: A Kid's Perspective

Beverly Cameron and Helen Blanch
G. Holmes Braddock Senior High School
Miami, FL

Abstract

Students enrolled in computer education classes at G. Holmes Braddock Senior High School, in Miami, Florida, began an exciting project unparalleled anywhere in the country. Their assignment: First-hand research of Hurricane Andrew and the effects of its aftermath.

These students are gathering photographs and video clips as well as taping interviews of victims, relief workers, journalists, storm experts, environmentalists, and politicians. They are conducting extensive research through a variety of formats such as on-line data bases, print media resources, and field trips.

The visual information that they accumulate will be edited, transferred to tape and later pressed on a laserdisc. In addition, the students are creating accompanying computer-based lessons using multimedia, presentation and graphic software for the Apple II, Macintosh, and MS-DOS computers.

This non-commercial project is being produced by kids for kids. It is our hope to share the final product with all the high schools in Dade County free of charge. All images appearing on the laserdisc and computer software, therefore, must be public domain or donated to the project.

Our presentation of this project at NECC '93 will include a brief description and visual displays illustrating the chronological progress throughout the school year. In addition, portions of the final multimedia package will be available for participant viewing. Detailed handouts will be distributed to attendees.

Chemical Conjurings: Student Multimedia Simulations

Vito M. Dipinto and Bonnie Thurber
National-Louis University
Evanston, IL

Abstract

The *Chemical Conjuring Project* is an expression of the continuing philosophy that guides the teaching of middle school students at the Baker Demonstration School (BDS) of National-Louis University. Content and process skills are integrated throughout the curriculum. Students construct their knowledge in a collaborative environment.

This project involves the eighth grade students at BDS, the science teacher, the technology teacher, and selected students in third, fourth, and fifth grades. As an essential element of their study of chemistry this year, the eighth grade students are designing a hypermedia simulation of a chemical investigation to introduce a third, fourth or fifth grader to the study of chemistry. The simulation is a preview for an actual investigation the individual third, fourth, or fifth grade student will perform under the guidance of the eighth grader.

The presentation of the *Chemical Conjuring Project* will include an example of one of the simulations, video tape highlights of the interactions between the eighth grader and the lower grade student, and a discussion of the themes emerging from student reflective writings on this experience and observational and anecdotal data from the teachers.

Projects (M3.11)
Logo & Instructional Applications

Polygons to Fractals: Logo Work With a Mathematically Gifted Student

Eadie Adamson
Educational Consultant
New York, NY

Abstract

If it is true, as Sylvia Weir has said, that learning disabled children show us normal learning in "slow motion," the experience of working with an exceptionally gifted child shows us learning in the "fast forward" mode. Two years ago a mathematically gifted fourth grade student was permitted to spend the year working with LogoWriter as a substitute for a fourth grade mathematics class. For the teacher, this work was a challenging and exciting collaboration with a student in which the changing role of teacher came strongly to the fore. For the student, it was a year in which intellectual challenge and pursuit of knowledge turned in new directions. The activities pursued and the results of one-on-one study give us a glimpse into the challenges and benefits of one very individualized collaborative approach to learning.

Beginning with polygons, moving on to writing functions, creating tessellations, and programming an orbiting meteor, the year's work also included exploring game-writing and inquiring into fractals. The astonishingly rapid grasp of complex programming ideas made this an exciting and very stimulating time for both teacher and student.

Projects developed in the course of this remarkable year of study will be demonstrated and discussed. Plans are to continue working with this student in the coming year. This is a non-commercial project.

This abstract was taken from the author's originally submitted proposal

Using Logo to Teach Critical Thinking Skills

Ron Place, Mike Sansing, and Chuck Auck
Logo Curriculum Publishers
Colorado Springs, CO

Abstract

Over the past seven years, classroom teachers Ron Place, Mike Sansing, and Chuck Auck of Colorado Springs, Colorado, have developed a computer curriculum to teach problem solving strategies and critical thinking skills. These materials have been used successfully as individual lessons at the elementary and middle school level and as a full semester computer science curriculum at the high school level.

This curriculum utilizes a turnkey approach. Each lesson is comprised of teacher materials with a corresponding handout for the students. The student worksheet incorporates the directed discovery approach to challenge the student to find the most effective way to solve the assigned problem. Students learn that the solution to any problem is a function of the surrounding circumstances. The graphics environment generates enthusiasm. The emphasis on top-down diagrams develops good organizational skills. The students are truly excited about attending class and begin working on their assignments before the bell rings. Beginning students who have used these materials in introductory courses have progressed through the higher level programming courses at a faster pace with great success.

The Middle School: Don't Work Easy, Play Hard!

Marian Rosen
Ladue Public Schools
St. Louis, MO

Abstract

At Ladue Junior High School in St. Louis, Missouri, all 250 sixth graders take a course titled Computer Assisted Thinking, or **CAT**, for short. The beliefs behind the course are (1) that all students need to have the kind of challenges that are usually offered only to the "gifted" and (2) that computers provide a unique opportunity to make this possible. An extension of this course is also available as an elective in the seventh grade. LogoWriter and Lego-Logo are important components of these courses.

This presentation will concentrate on the beginning Logo project which teaches the geometry of polygons, and the use of variables. The project is defined in such a way that slow students can succeed and faster students may excel. Samples of student work will be shown, and there will be a handout of the materials used to make this project successful.

In Bloom's Taxonomy, application, analysis, and synthesis are considered higher than knowledge. It is often true in Logo classrooms that students know how to draw polygons or use a variable, but can't use this knowledge to analyze a problem or create a drawing or to independently recognize places where variables are useful. Time permitting, this presentation will include a brief discussion of teaching tricks that help facilitate this development.

There is no commercial product or venture involved in this project. The information given is applicable to all versions of Logo.

This abstract was taken from the author's originally submitted proposal

Projects (M3.12)
Teacher Training

Making Magic in Texas: Telecommunications Assist Universities

Brad Chilton
Tarleton State University
Stephenville, TX

Abstract

The "magic of technology" in telecommunications is being made available to present and future educators through the use of The Texas Education Network (TENET) at Tarleton State University located in Stephenville, Texas. Through the use of TENET, teachers are being exposed to the wide range of telecommunication services that may assist in the instruction of students.

The creation of TENET was mandated by the state legislature. The network provides the capability of access to every school district in the state. Fifteen metropolitan centers have local telephone access while 800 telephone service is also provided. The chief services offered by the network include electronic mail, news groups, conferencing, databases and internet resources.

TENET is currently reinforcing the arrival of the "age of technology" at Tarleton. At the undergraduate and graduate levels, it is currently being taught as a major component in several courses.

University students at every level seem amazed at the "magic of learning" offered by TENET. Tarleton State University hopes that it will be able to assist in the growth of the use of telecommunications by exposing educators to the uses of TENET.

Mathematics Education and Advanced Technologies: A Collaborative Inservice Model

Neal Grandgenett and Robert Mortenson
University of Nebraska at Omaha
Omaha, NE

Abstract

It is becoming increasingly difficult for mathematics teachers to stay knowledgeable on new and emerging technologies for use in the secondary mathematics classroom. A collaborative inservice model is being used in Omaha, Nebraska to help train teachers in six different metropolitan Omaha school districts on advanced mathematics education related technologies. The inservice model in the project uses awareness, experience, and integration related phases of activity to assist teachers in using a variety of advanced technologies for classroom instruction. Instructed technologies in the project include spreadsheets, graphing calculators, hypermedia, symbolic processing packages, computer aided design, and statistical analysis packages. Initial indications suggest that the inservice model being used is an effective way to help teachers integrate technology into their districts' courses and curriculum. In particular, the inservice project appears to be very successful in encouraging teachers to become active technology users in their own classrooms, and to assist colleagues with related technology interests in learning more about educational technology and its applications.

EPSS: A New Approach to Staff Training

Pamela Zimpfer and Doris Nabi
Center for Educational Technology
Florida State University
Tallahassee, FL

Abstract

This presentation will provide an overview of electronic performance support systems (EPSS). EPSS is the new discipline that emerged from a business and industry community frustrated by the need to increase competency and performance of employees and the inability of traditional training approaches to effectively and efficiently meet that need.

The goal of an EPSS is to provide staff with embedded job performance aids and learning sequences, tied to specific job tasks and learning needs, that are accessed at the moment of need. In the past, this kind of job support could be provided only by supervisors, trainers, and peers. Advances in technology and research into performance support systems now make it possible to model, represent, structure, and implement that support electronically.

As the focus of this initial application of EPSS, staff who provide education and services for exceptional students are targeted because of their critical job performance requirements. In particular, these staff require detailed information, access to current practices, and a wide variety of data to meet the individual needs of each student. The project is sponsored by the Florida Department of Education's Individuals with Disabilities Education Act (Part B), Special Projects.

This project is currently a non-commercial initiative.

This abstract was taken from the author's originally submitted proposal

Projects (M3.13)
Multimedia & Instructional Applications

See to Say Multimedia Literature Experiences for Bilingual Children K - 5

Jack Baumann
Sharon Gallivan
Grace Hom
Los Angeles Unified School District
Model Technology Schools Project
Los Angeles, CA

Abstract

We have observed that many of our limited English children enter school with a lack of experiential knowledge that prepares them to understand the curriculum of a traditional classroom. A "Family Profile Survey" showed that less than 40% of our 1800 students have visited the zoo, beaches, or any of the local museums, all of which are within a 20 mile radius of our school.

"See to Say Literature" bridges the visual needs of the children with the communicative goals of the State of California's Language Arts and Science Frameworks. Through interactive laserdisc and computer activities, our children are able to see for themselves what they have not been able to experience first hand. Thus their language capabilities increase substantially with every exposure to multimedia experiences. It also provides the children with means to write what they have seen or read about and to create stacks/folders to organize and maintain information for future reference or presentations. The children's response to learning in this modality has been tremendous. Both teachers and children express a greater joy and continued desire to create more and more exciting "See to Say" presentations and interactive stacks/folders to enrich their daily educational program.

750,000 Students Under the Sea: Supportive Bilingual Multimedia Science

Ward Cates
Lehigh University
Bethlehem, PA

Abstract

This presentation discusses design work underway at the S.M.A.R.T. (Science Model Area Resource Team) Center at Lehigh University. The Center is designing a multimedia learning environment for science instruction based on the Jason IV Baja California Sur project. The Jason IV project took place this year off Baja California and Mexico, exploring whale migrations, plate tectonics, biological activity, and newer scientific technologies. Students from all over the world participate in the Jason project, and this year it broadcast in both English and Spanish.

This presentation discusses the design of that computer-based learning environment. The environment encourages scientific exploration and manipulation, while at the same time providing lots of instructional support for learners in the form of built-in advisement and coaching functions, a formal link to curricular emphases, and support for hypothesis-testing. Taking advantage of the Jason project's bilingual broadcasts, the design incorporates bilingual features; bilingualism is not simply an add-on or afterthought.

Illustrations of specific computer screens and incorporated advisement features are discussed, as are ways in which teachers might make the most of instructional products utilizing such a design.

Enabling Students Through Hypermedia and Multimedia Creates Magic

Terry Cahill Frost and Barbara Awerkamp
Arizona State School for the Deaf and Blind
Tucson, AZ

Abstract

Pilot classes at the Arizona State School for the Deaf and Blind are now in their second year of an Apple Crossroads Grant. Two of its elementary Deaf classrooms have used an integrated approach for learning English through reading and writing with the use of hypermedia and multimedia projects. Yes, it is possible to have second and third grade students be active participants in using hypermedia in all aspects of learning, not just for the finished project! We will demonstrate how the students were able to gather information, synthesize and then apply what they had learned using hypermedia as their basis for gathering and implementing research. We are concerned with the process of learning as much as, if not more than, the final product.

Our focus of learning was "Community and Culture." The children developed interview techniques to learn how members of the Deaf community impact Tucson. They have taken this information and, with the help of Bank Street Writer, have gone through all the steps of research and process writing to produce a project to show their fellow students and the Deaf community. These students were able to implement such skills as using QuickTime, scanning various materials and accessing audio clips.

Our students' confidence soared in all areas: computer skills, interpersonal relationships, and communication skills in both American Sign Language and written English. The students also have a real sense that when they grow up as Deaf members of this society there is a place for them!

Infusion of Technology into the Curriculum

Carolyn Chambliss, Diane Kornegay , and Debra Bell
Andrew A. Robinson Elementary School
Jacksonville, FL

Abstract

Session participants will see how a large, inner city elementary school uses technology to enhance the productivity of teachers, students, and administrators. Participants will learn how the infusion of technology into the curriculum motivates performance of underprivileged, at risk students. Participants will learn how technology can be used to address multiple learning styles, facilitate cooperation, and promote lifelong learning skills. An emphasis will be placed on the use of technology as a tool which empowers students to pursue purposeful academic exploration and extend critical thought. A variety of teacher/student products created with HyperCard, MacroMind Director, and Adobe Premier will be demonstrated and discussed along with several alternatives to traditional research reporting. The presentation will focus on how the use of computers operating in classrooms and labs, a still photography lab, a video production and distribution system, an interactive multimedia production lab, integrated learning systems for reading, mathematics and science, and a research lab in the media center can be used to build and enhance academic performance within all subject areas.

Projects (M3.14)
Potpourri

Evaluating the Academic Impact of Technology in Science

Shirley Becnel
Jefferson Parish Public Schools
Marrero, LA

Abstract

For the past four years, the Chapter 2 department of the Jefferson Parish Public School System has supported a districtwide science technology project involving 12 middle/junior high schools. The purpose of the project is to select and use appropriate computer software and hardware in the district's science curriculum. The project is being implemented over a five year period with both process and product evaluations taking place throughout this period. During the first two years of the project (1988-90), the focus was teacher training and preliminary field testing in the classrooms. The third year of the project (1990-91) involved the formal use of the software in the classrooms as part of the instructional program. The fourth year (1991-92) of the project focused on the controlled use of specific software titles in the seven major secondary science areas. Using an instructional design model which included specific assessment measures for each class, data were collected regarding student population, the academic achievement of the students, the instructional processes used by the teachers, and the perceptions of the participants re: the effectiveness of the software delivery system. The purpose of the evaluation was to assess the degree to which the instructional software impacted student achievement in science. Fifty-nine regular classroom teachers and 1,868 secondary school students participated in the project, and data from the 63 field tests were used to assess program effectiveness.

Assessment of the project's success was predicated on the evaluation component included in the instructional plan submitted by each teacher. Each plan included goals and objectives specific to the software title, a pre and post measure of student performance, and a description and copy of the test materials used to assess student knowledge. Project data were collected via two project status forms and were entered into a PARADOX relational data base for manipulation and linkage with the district's testing files. Each field test was evaluated both individually, using criterion reference measures, and on a district level, according to the software titles used with the students.

The analysis of the data showed that the product design was appropriate and that 87% of the teachers implemented the field tests as proposed. 98% of the titles were appropriate for classroom use, and 85% were effective in improving student performance. Only one software piece used this year was deemed to be too cumbersome for effective use. Three titles contributed to significant increases in student performance, and these titles will become required instructional activities in the 1992-93 school year. The overall instructional design, as well as the data collection procedures, continue to yield useful data and will be used in the fifth and final year of the project (1992-93 school year).

The proposed presentation will include a discussion of the data re: student performance and a listing of the hardware and software used in the project. Copies of the instructional model, reporting forms, and evaluation design will be distributed.

This project was funded by federal monies allocated to Jefferson Parish and is a non-commercial venture.

This abstract was taken from the author's originally submitted proposal

Respect and Recognition: A Staff Development Model

Cathy Hutchins and Roger Coffee
Webster Elementary School
St. Augustine, FL

Abstract

This presentation will outline how staff development has played a critical, yet vital role in a designated Florida Model Technology School. Teacher inservice training using various types of technologies including the use of Apple and IBM computers, networked and individual workstations, camcorders, CD-ROM, videodisc players, hypermedia and video productions will be discussed.

Now in their third year of the project, they will share their successes, pitfalls, and tips, including a unique concept known as "teacher experts." A media presentation featuring staff development highlights and teacher samples will be shared.

Hi Tech Summer School—Chapter One Students

Kathy Rehfield-Pelles
NY Public Schools
White Plains, NY

Abstract

In the summer of 1992, the White Plains Public Schools in New York made a commitment to extend the school year for students in the Chapter One program and to provide them with a summer school program for the first time. After evaluating several different designs for keeping these students involved academically during the summer, and for encouraging their involvement with the language skills of reading, writing, and speaking, the district adopted a Hi Tech model.

The Hi Tech Summer School utilized the computer, video, TV, audio and related equipment from throughout the entire district. The presentation will present some of the thematic units undertaken in the curriculum and some of the products produced by students. It will highlight the software used successfully in the program, as well as some of the creative applications developed for software. The evaluation of the program will be shared in the presentation, along with the design elements considered crucial for the future success of this Summer School model.

Posters (M3.15)
Teacher Training

Preservice Teacher's Ability to Evaluate CAI: Do Advanced Organizers Help?
Robert Fons
Central Kentucky Education Cooperative
Lexington, KY

Portfolio Assessment/Technology/Teacher Preparation: Experiment in Progress
Kathy Hammons, Patricia Kalfsbeek
Saint Mary's College
Danville, CA

Developing Technology Leadership in School Library Media Specialists
Nancy Todd
Eastern Washington University
Cheney, WA

Computer Literacy as a Process
Marty Wolf
Minnesotta State University
Mankato, MN

Spotlight Sessions (M4.1)

The Future of Textbooks: Electronic vs. Print

Sylvia Charp
T.H.E. Journal

Mike Eason
Florida Department of Education

Janelle Leonard
Texas State Department of Education

Bill Barnett
Harcourt, Brace, Jovanovich, Inc.

Abstract

This panel will discuss the electronic textbook — what is available today and what is coming in the future, how it will impact our schools and the textbook publishers, the potential of the electronic textbook to enhance education for teachers and students, as well as potential pitfalls.

This abstract was taken from the author's originally submitted proposal

Spotlight Sessions (M4.2)

Electronic Assessment

Irwin Kirsch
ETS

Jerry Morgan

Abstract

Abstract not available at press time

Spotlight Sessions (M4.3)

It Takes Two to Tango: Hypermedia and Videodiscs

Perry Reeves
Pioneer New Media
Carson, CA

Roger Wagner
Roger Wagner Publishing, Inc.
El Cajon, CA

Abstract

Abstract not available at press time

Spotlight Sessions (M4.4)

Applying Technology Standards in the Accreditation of Teacher Preparation Programs

Joyce Friske, Panel Chair
Jenks Public Schools
Jenks, OK

Abstract

The ISTE accreditation committee will discuss the programs in educational computing and technology that have been recently approved by NCATE, and their potential impact as they are applied in technology teacher preparation programs throughout the United States. Examples will be presented that describe how those standards can be applied in the areas of computer/technology literacy, computer science education and educational computing, and technology leadership programs.

The committee will also discuss changes that have been recommended to NCETE from ISTE concerning the unit accreditation standards, and provide examples of how teacher preparation programs are applying them in the preparation of all teachers.

As a part of this session, participants will be asked to share and discuss their experiences, perspectives, and/or concerns about accreditation programs in educational computing and technology and to respond to those NCATE unit standards that have an impact on the technology preparation of all teachers.

Panelists:

LaJeane Thomas
Louisiana Tech University
Ruston, LA

Don Knezek
Educational Services Center, Region 20
San Antonio, TX

Sally Sloan
Winona State University
Winona, MN

Harriet Taylor
Louisiana State University
Baton Rouge, LA

James Wiebe
California State University—Los Angeles
Los Angeles, CA

Society Sessions (M4.5)

Teaching With A Story Generator

Association for Small Computer Users in Education (ASCUE)
R. Waldo Roth
Taylor University
Upland, IN

Abstract

This session will discuss and demonstrate a software program, *The Linear Modeling Kit*, and its use in the classroom. The *LMK* generates narratives according to principles it is given by the user. These principles may be abstracted from formal literary theory or they come from the user's own ideas about a particular kind of narrative. Once the principles have been entered as elements and combinatory rules, the program will generate a variety of narrative skeletons.

In the classroom, use of the *LMK* stimulates and focuses discussion of narrative and allows narrative theories to be tested by their productivity: do they allow the *LMK* to generate the kind of story they claim to describe? If not, is the problem in the ideas or in the attempt to get them into the *LMK*?

Although we have used the program primarily in undergraduate literature courses, we will suggest how it might be used in secondary schools and in other disciplines.

The session itself will be an interactive one with participants becoming a class in which this new teaching tool is used.

Panelist:

Peter Havholm and Larry Stewart
The College of Wooster
Wooster, OH

Society Sessions (M4.6)

Making REAL Internet Connections: Experiences from the National School Network Testbed

Society for Computer Simulation (SCS)
Denis Newman
Bolt Beranek and Newman Inc.
Leucadia, CA

Paul A. Reese
Ralph Bunche School
New York, NY

Abstract

We have begun to extend real Internet connections to schools as part of a project to test the feasibility of a national school network. The goal of such a network is to make available to schools up-to-date scientific resources, to engage students and teachers in authentic problem-solving, and to support the implementation of advances in pedagogy and educational technology. This special session will report the results of our first year of work during which we established, with the support of the National Science Foundation, a prototype network connecting schools, school districts, and national organizations, each with their own network information servers, directly to Internet regional providers. Teachers, students and administrators in Massachusetts, New York City, and San Diego County are among the very first in the country to be experimenting with direct network connections between their desktop computers and the worldwide Internet. These REAL Internet connections (in contrast to the dialup, terminal-host connections typical of almost all telecomputing in the schools) provide immediate access to multimedia e-mail, world-wide bulletin boards, multi-user simulations, and massive databases maintained by universities, libraries and government agencies.

Society Sessions (M4.7)

Alternative Approaches to Laboratories for Introductory Computer Science

Special Interest Group on Computer Science Education (ACM / SIGCSE)
Lillian Cassel, Moderator
Villanova University

Debra Burton, Presenter
University of Texas, Austin

Abstract

The following four approaches will be discussed and materials will be demonstrated:

1. Closed labs
2. Supervised labs
3. Independent labs
4. Demonstration labs

This abstract was taken from the author's originally submitted proposal

Paper (M4.8a)
Learning With Computer Software: What Knowledge Actually Transfers?

Robin H. Kay
University of Toronto, Canada

Abstract

The notion of transfer, or the extent to which knowledge acquired in one situation transfers to another situation, is particularly important in today's rapidly evolving computer software market. Identifying the nature of transfer is a critical step toward guiding computer-based instruction in a more efficient manner. The purpose of this study was to investigate the nature of transfer in the domain of computer software. Fourteen adults (6 male, 9 female) were videotaped for 60 minutes, with the camera focused on the screen while they attempted to learn a series of tasks in a common spreadsheet package. Subjects were asked to think out loud while they learned. A formative analysis of these think-aloud protocols revealed four categories of previous knowledge used: general skills, metaphors, metacognitive knowledge, and use of terminology. While general skills appeared to transferred little, metacognitive knowledge was observed to transfer often and successfully. Mixed results were noted for the transfer of metaphors and terminology. Practical recommendations are offered for teachers and researchers of computer-based instruction.

Introduction

One of the more astounding phenomena of the last two decades is the almost breath-taking pace at which computer software and hardware has developed. Lepper (1985) puts this growth into perspective:

> Had improvements in efficiency and reductions in the cost of automobiles followed patterns similar to the computer industry, each of us would be able to buy a Rolls-Royce today for roughly $2.75; it would get nearly 3,000,000 miles to the gallon and would deliver enough power to tow an aircraft carrier (p.1).

This kind of rapid change has put considerable stress on educators of computer studies. Teachers are face two fundamental problems: what to teach (content) and how to teach it (process). Defining ***what to teach***, or ***computer literacy*** as it is more commonly known, has proven to be an illusive endeavour. The concept of computer literacy has flourished into a myriad of conflicting meanings and purposes leaving a somewhat indefinite result (Kay, 1992b). Developing programs on *how to teach* computer studies is also fraught with complications. The broad variety of software designs available have produced inconsistent command languages, confusing operation sequences, chaotic display formats, incomplete instructions, and complex error recovery procedures that teachers are required to deal with on a daily basis (Shneiderman, 1989). Teachers may feel that time spent teaching a particular software package on a particular computer may we waisted given that new software, upgrades, or technology are just around the corner.

Educators of computer studies, then, have to develop strategies to keep pace with a constantly changing content. One approach to dealing with this problem is to examine the nature of knowledge transfer, or the extent to which previous knowledge is useful for learning new tasks (Singley & Anderson, 1991). A critical debate in research on transfer rests on defining the appropriate cognitive unit of transfer (Sternberg, 1989). By cognitive unit, I mean the abstract level at which information learned is likely to carry over from one domain to another. For example, one might be interested in the kind of knowledge that transfers from general math ability to spreadsheet software; or one computer system (Macintosh) to another (IBM); or even one kind of word processing software package (WordPerfect) to another (Microsoft Word). In these examples, I have moved from general units of transfer (math skills) to more specific units (specific software packages). Discovering promising units of transfer is a meaningful step toward teaching computer studies in a more effective way. In other words, identifying general features or strategies that can be taught so that students can learn a variety of future software packages is one way of addressing unwavering software development and growth.

Intuitively, it would appear that general problem solving strategies would be the most efficient level of ***cognitive unit*** to teach. Teaching a set of general skills, independent of a particular software context, appears to be a promising way to combat constantly changing software content. Certainly, this kind of context-independent approach is deeply rooted in other areas of education (Resnick, 1989). But researchers have produced abundant evidence to suggest that general problem solving skills do not readily transfer to different contexts (e.g. Resnick, 1989; Singley & Anderson, 1989; Voss, 1989). In fact, some have argued that teaching decontextualized knowledge or general skills can be detrimental to learning (Resnick, 1989).

The lack of success in using general units of transfer has spawned significant interest in the role of context in learning and transfer. A growing number of researchers have reported that a certain degree of similarity in context between old and new learning situations is critical for previous knowledge to transfer (e.g. Brown & Palinscar, 1989; Chi & Bassok, 1989). Considerable evidence suggests that teaching learning strategies within a specific context is highly successful in a variety of areas including reading (e.g. Brown & Palinscar, 1989), mathematics (e.g. Lampert, 1986), mechanics (e.g. Chi & Bassok, 1989), and writing (e.g. Collins, Brown, & Newman, 1989). Similar studies in the domain of computer software have been noticeably absent. Instead computer-based studies have taken the form of paper-and-pencil surveys designed to measure constructs of computer ability (construct approach) (see Kay, 1992d), or investigations designed to improve the design of computer interfaces (Carroll, 1991; Norman & Draper, 1986). Neither of these approaches, however valuable in themselves, provides a clear understanding of how previous knowledge is used during the learning process. In order to increase this understanding and improve cognitive transfer in computer software, it is critical to go beyond computer ability measures and improving interfaces, and investigate the knowledge building ***process***. "Identification and analysis of thinking strategies involved in both sound and faulty thinking is clearly the meat and potatoes that provide a sound base for educational efforts to teach thinking" (Kuhn, 1990, p. 3).

The purpose of this study, then, is to (a) describe what kind of previous knowledge is used in learning new software, (b) assess the effectiveness of this knowledge in aiding the learning process, and (c) provide recommendations for computer-studies educators. Please note that the results are descriptive and anecdotal. The current study is meant to be a formative analysis.

Method

Theoretical Background

A majority of educational researchers and educators have used a construct approach to evaluate computer ability or learning (Kay, 1992d). Conspicuously absent from these measures is data on how the subject interacts with a computer, the context of computer use, and the goals and needs of the individual. This information on process, though, is critical for understanding transfer (Bannon & Bodker, 1991; Keating, 1990; Kuhn, 1990). A microgenetic approach—one the examines the detailed learning over short time-periods—is offered as a promising example of a process-oriented method that could produce a richer metric of computer ability for researchers and educators. This study used a modified microgenetic format (Keating, 1990; Kuhn, 1990), where each subject's behaviour was recorded during a one-hour learning session.

Sample

The sample consisted of 14 adults (8 graduate students and 6 professionals; 5 male, 9 female), ranging from 25 to 37 years of age, who volunteered to participate in the study. From two ability and one attitude surveys (see Kay (in press a, in press b) for scale details), plus a pre-test interview, subjects were assigned a computer experience rating of beginner (used only one software package, less than one year), intermediate (used two or more software packages for over a year), and advanced (used a variety of software packages for 3 or more years). (See Kay (1992c) for detailed description of the rating system). There were five beginners, four intermediates, and five advanced users.

Computer Activity

Subjects' computer activities were videotaped for 60 minutes, with the camera focused on the screen, while they attempted to learn a common spreadsheet package (Lotus 1-2-3, Version 2.2) on an IBM, 80286 clone. Subject were asked to do as many of the following tasks as they could: (1) move the cursor, (2) enter rows and columns of numbers, (3) enter labels, (4) insert blank rows and columns, (5) move and/or copy rows or columns of data, (6) compose formulas to add numbers, (7) create graph, and (8) create a macro. More advanced users started at higher level tasks.

The standard procedure was to introduce the subject to a task and encourage self-directed learning. Each subject was asked to think out loud while learning. Every effort was made to encourage subjects to get "unstuck" on their own. Unlike typical protocol analysis (Ericsson & Simon, 1984), subjects were given calculated "hints" when they were unable to proceed. The criteria for determining when a subject was stuck was determined informally, often based on (a) the subject asking for help, (b) the subject's frustration level, and (c) the time as subject took to finish a task. The criteria for hints, also determined informally, was based on a subject's progress and frustration level.

The first 50 minutes of each of the fourteen videotaped session was transcribed. Verbal expressions and sounds, as well as critical keystrokes, were included in the transcriptions. The results of this pilot study consist of a series of episodes from these transcripts, offering anecdotal evidence documenting specific patterns of transfer.

Results and Discussion

Four categories of previous knowledge were used by subjects in the spreadsheet learning situation. These included general skill, use of specific metaphors, metacognitive ability, and terminology. An overview of each knowledge type, along with anecdotes and a general impression of whether the knowledge type was effective, will be presented.

General Skill

For the purpose of this study, general skill is defined as knowledge that (a) is not associated with a specific context, and (b) supports higher level goals. Only two types of general skill emerged spontaneously while subjects learned new tasks: mathematical/programming knowledge and typing skill.

Mathematical and programming ability. Only one subject used mathematical and programming skills to solve new problems. This subject had substantial knowledge and interest in both computers and mathematics with graduate degrees in both areas. In one instance, she was asked to enter in a formula that would add a column of numbers. With a strong background in numbers, formulas, programming, math and computers, and an example in front of her, one would predict successful completion of this task in a relatively short time. The task took her almost 20 minutes (19:51) to complete, whereas most other users finished the same task in less than 5 minutes. Her problem stemmed from using a relatively extensive system of error checking, normally reserved for checking programming errors to solve a simple syntax problem. She also used her mathematical knowledge of truncation and rounding errors, to explain why her incorrect formula didn't work. Her broad knowledge and experience may have inhibited her progress on this moderately difficult spreadsheet task. The mathematical/programming model may work well in a programming environment, but an intentionally user-friendly application environment alters the context enough so that relatively straightforward tasks may become time-consuming and effortful.

Typing. Typing skill would be considered by most people to be an asset for using computers. Most subjects in this study used a "hunt-and-peck" approach. Three subjects, though, were skilled typists. Their ability to type, at times, prevented them from exploring how certain options worked. For example, they maintained that it was faster to type the formula over again than to figure out how the "more efficient" edit keys worked. Whereas typing skill may be important to enter information, it may not be especially helpful for learning new software. A slow, deliberate pace was most effective, allowing subjects sufficient time to observe the consequences of their keystrokes.

Overall, general skill did not play a consequential role in learning spreadsheet software. This finding is consistent with previous research results (Resnick, 1989; Singley & Anderson, 1989; Voss, 1989)

Specific Metaphors

In contrast to general skill, metaphors or models are associated with a specific context or task. Most subjects used at least one of the following metaphors when attempting to learn new spreadsheet tasks: a previous software package, icons/menus, graphs, calculators, games, and bank machines. These metaphors were used with mixed success.

Previous software. Seven subjects spontaneously used word processing skills to learn tasks such as entering numbers, and moving and copying text. For example, six of the seven subjects hesitated after typing their first number into the spreadsheet. Lotus 1-2-3 requires that you press the enter or cursor to insert a number into the spreadsheet. Until one of these keys is pressed, the number entered appears and remains in the top left corner of the screen. This idiosyncrasy particularly surprised, and to some extent, hindered beginners who claimed the procedure was different for word processing. Two other subjects openly claimed that their word processing knowledge of copying and moving helped them understand the same procedures in the spreadsheet software package.

One beginner used her knowledge of a statistical package called SPSS to guide her spreadsheet learning. The SPSS software package is quite different from Lotus 1-2-3 in terms of input format, screen design, commands used, and overall purpose, so it is not surprising that this user experienced a number of difficulties. Transfer errors were both syntactical and conceptual, yet she persisted in using this software metaphor.

Icon/Menu metaphor. A metaphor based on icon or menu driven software, commonly associated with Macintosh computers, was troublesome for subjects who attempted to use it with spreadsheet software. The most common difficulty was experienced when attempting to move or copy text. Two subjects wanted to block off text (as if they were using a mouse) when trying to move numbers from one location to another. Six subjects attempted to use cursor keys to move vertically in the spreadsheet menu. Although this would be the right way to move around a Macintosh menu, the correct procedure for the Lotus 1-2-3, spreadsheet menu was to press the enter key.

One subject, who owned a Macintosh computer, was so entrenched in the icon/menu" metaphor that she repeatedly expressed animosity toward the software. She noted from the start that the software looked "pretty boring" and that the opening screen was "telling her nothing," whereas other subjects noted helpful details from the same screen. She regularly commented that most operations seemed excessively cumbersome. Although this attitude prompted her to seek more efficient solutions to some problems, it also inhibited and restricted her observation certain keystrokes effects. When I introduced the spreadsheet menu, she was clearly happy, exclaiming "Yahoo", but when the menu did not work like a Macintosh menu, she retreated into her critical and evaluative position.

Even though this subject's fixation on the "Mac" way of doing things is only one example, it seems reasonable to assume that individuals learn a variety of software packages on a variety of computers, and that a certain degree of fixation occurs. This is tangentially related to the broader issue of theory fixation (Sternberg, 1989) or functional fixity (Lewis & Norman, 1986). Sternberg (1989) argues that knowing too much (or using something too long) produces a deep structure that can seriously impair functioning.

Graphs, calculators, and games. Other metaphors used were based on knowledge of graphs, calculators, and games. One beginner described the opening screen as an inverted graph—she quickly adjusted her metaphor when she saw the cursor move, labelling the screen more appropriately as "a grid". Another beginner, when asked to add numbers, claimed he was looking for something on the keyboard that was similar to a calculator. He also said that one way of doing the task would be to add the numbers with a calculator and enter the sum into the spreadsheet. This would clearly undermine the power of using spreadsheet software. An intermediate subject, after experiencing some difficulty using fancy formatting commands, claimed that he was sure there was some "trick" to doing the task, as there might be in a game. While computers often appear to be "tricking" unsuspecting users, in this instance the "trick" metaphor prevented him from noticing a simple syntax error.

Banking machine metaphor. Six subjects had substantial difficulty with moving and/or copying text. Problems stemmed from the desire to block text with a mouse, expecting the use of buffers (commonly used in programming), and excessive emphasis placed on the position of the cursor. One beginner, though, completely the task quickly and without error. Given her limited experience, I thought this was remarkable. After some thought, she said "it was like using a bank machine where you transfer money from one account to another".

Summary

The use of metaphors appeared to be a hit-and-miss proposition. The use of previous software packages and common everyday metaphors showed intermittent success. More often than not, a metaphor allowed a subject to move from a state of inactivity, to one where some action was possible. For example, when one subject did not know how to enter data, she would use a word processing method. Even though this method was not correct, it at least permitted her to proceed and eventually correct her initial misconceptions. The role of metaphors as a catalyst might be indirectly useful, particularly when a subject is faced with a completely new task. Perhaps, if the use of metaphors was taught explicitly, as in previous research, it might be an effective guide to learning.

Metacognitive Ability

An impressive list of metacognitive abilities were observed in this study, including: sensing difficulty or that a problem existed, recognizing that an activity has been done before (deja-vu), sense of efficiency, knowing the computer's limits, noting when enough effort had been made and when it was time to seek help, sensing what might be helpful, and having a feel for unusual terminology. Space does not permit a detailed analysis of these metacognitive abilities. I will make only three points here. First, with the exception of two beginners, and one intermediate, metacognitive ability was exhibited by advanced users only. Second, this kind of knowledge was consistently useful in guiding progressive problem solving. Third, these metacognitive abilities often took the form of hunches. Subjects were not necessarily consciously aware of why they were doing what they did. The would often casually comment "That's too much work. There must be a better way" or "I'm over my head here, I should look for help", instead of stating specific reasons for their actions.

Metacognitive ability, although extremely useful and transferrable, might be a kind of knowledge that develops slowly and unconsciously over time. The challenge would be to maximize metacognitive development, perhaps by making users explicitly aware of it.

Terminology

Vygotsky (1978) was a pioneer in exploring the role of language in thought. He noted that conceptual learning was a collaborative effort requiring supportive dialogue. Bruner (1986) added that conceptions of knowledge, thought, and learning are "fulfilled, impeded, and distorted by the way in which we talk about the world and think about it in the coin of that talk" (p. 121).

A primary aspect of learning in a particular environment is the language that individuals use to communicate to each other about commonly perceived actions and events (Bruner, 1983). As any novice will tell you, there is a definite (or indefinite) language used in a computer environment that has to be acquired in order to function effectively (Turkle, 1984). Subjects' use of terminology in this study appeared to influence knowledge acquisition.

Some subjects had vague ideas about their actions. For example, two intermediate users knew that "commands" solved problems. When asked how they might pursue a particular task, they would often say "there would be a command". Commands were perceived as the panacea for all software problems. Unfortunately, this inhibited them from actively building their knowledge. A clearer understanding of the concept of commands, namely that they are interconnected and tend to appear in extended sequences, might have altered the knowledge building process.

Sometimes subjects did not have terminology to describe an action or task. It was not that their terminology was vague—they simply had no words to describe their actions. One subject noted that "things were changing" when asked what was happening as she moved the cursor horizontally along the spreadsheet menu bar. Without a language to describe her actions, she was unable to notice the details of menu operation and seemed reluctant to explore further. This strongly influenced her future menu actions—she was often confused and disoriented when moving from the worksheet to the menu.

Several subjects appeared to have a clear understanding of how spreadsheet worked, but used terminology that was nonstandard, particularly when learning a new detail. Their attempts to articulate these actions appeared to instantiate these concepts in their minds, as they were able to apply these actions in future learning situations, unlike users who used vague descriptions. Incorrect terminology, though, can cause serious problems—several subjects experienced orientation problems and difficulties finding help because the words they were using were conceptual incorrect.

Terminology is clearly integrated with learning in a computer environment. Vague terminology deters exploration and sometimes prevents subjects from forming a clear understanding their actions. Non-standard terminology may be useful in communicating to oneself, but difficulties arise in a more populated setting. Incorrect terminology can cause heightened confusion. This brief protocol analysis illustrates the difficulty of learning a new language and how important that language is to adequate concept formation.

Practical Recommendations

Although the results of this study are formative, certain practical recommendations, *while highly speculative at this point*, can be suggested for teachers of computer studies. These recommendations could also be thought of as list of research hypotheses for future studies. They are as follows:

a. General knowledge based on mathematic, programming, and typing may not particularly useful for the initial learning of spreadsheet software.
b. Specific metaphor use (e.g. word processing, graphs, bank machines), if introduced in a systematic way, could be useful for students.
c. Metacognitive skills should be made explicit to new users. While these metaphors may not be useful initially, they may help to guide future attention toward critical components of a software package.
d. If students are encouraged to articulate their actions, they may develop a stronger vocabulary for and understanding of the software they are learning.

Warnings

The results of this study also offer a series of warnings that should be noted:

a. There seems to be a delicate balance between giving too much and too little context. Too much context results in fixation. Too little context prevents subjects from noticing common elements between old and new learning situations;
b. When teaching, be aware that a student may have difficulty abandoning their favourite, but inappropriate metaphors. It is important to intervene early to correct misconceptions;
c. A slow pace is not necessarily bad, particularly if the student is taking time to evaluate his or her actions;
d. Hunches and guess should be encouraged, especially when they are talked about out loud and followed by evaluation. They may be precursors to metacognitive knowledge.

References

Bannon, L. J., & Bodker, S. (1991). In J. M. Carroll (Ed.), Designing interaction. (pp. 227-253). Cambridge: Cambridge University Press.

Brown, A. L., & Palinscar, A. S. (1989). Guided, cooperative learning and individual knowledge acquisition. In L. B. Resnick (Ed.) *Knowing, Learning, and Instruction.* Hillsdale, NJ: Erlbaum Associates (pp. 393-451).

Bruner, J. (1983). *Child's talk. Learning to use Language*, Toronto: George J. McLeod Ltd.

Bruner, J. (1986). *Actual minds, Possible Worlds.* Cambridge, MA: Harvard University Press.

Carroll, J. B. (1991). Introduction: The Kittle House manifesto. In J. M. Carroll (Ed.), Designing interaction. (pp. 1-16). Cambridge: Cambridge University Press.

Chi, M. T. H., & Bassok, M. (1989). Learning from examples via self-explanations. In L. B. Resnick (Ed.) *Knowing, Learning, and Instruction.* Hillsdale, NJ: Erlbaum Associates (pp. 251-282).

Collins, A. Brown, J. S., Newman, S. E. (1989). Cognitive apprenticeship: Teaching the crafts of reading, writing, and mathematics. In L. B. Resnick (Ed.) *Knowing, Learning, and Instruction.* Hillsdale, NJ: Erlbaum Associates (pp. 453-494).

Ericsson, A. K., & Simon, H. A. (1984). *Protocol Analysis: Verbal Reports as Data.* MIT Press.

Kay, R. H. (in press a). Exploring theoretical and practical foundations for assessing attitudes toward computers: The computer attitude measure (CAM). *Computers in Human Behavior.*

Kay, R. H. (in press b). A practical research tool for assessing ability to use computers: The computer ability survey (CAS). *Journal Research on Computing in Education.*

Kay, R. H. (1992a). The acquisition of computer knowledge: A formative analysis. Thesis in preparation)

Kay, R. H. (1992b). The computer literacy potpourri: A review of the literature or McCluhan revisited. *Journal of Research on Computing in Education*, 24(4), 446-456.

Kay, R. H. (1992c). Charting Pathways of Conceptual Change in the Use of Computer Software: A Formative Analysis. *Journal of Educational Computing Research.*

Kay, R. H. (1992d). Understanding and Evaluating Measures of Computer Ability: Making a Case for an Alternative Metric. Manuscript submitted for publication.

Keating, D. P. (1990b). Developmental processes in the socialization of cognitive structures. *Proceedings of a symposium in honour of Wolfgang Edelstein on his 60th birthday*, Berlin: Max-Planck-Institut fur Bildungsforschung.

Kuhn, D. (1990). Introduction. In D. Kuhn (Ed.), Developmental perspectives on training and learning skills. Contributions to human development: Vol 21 (pp. 1-8). Basel, Switzerland: Karger.

Lampert, M. (1986). Teaching multiplication. *Journal of Mathematical Behaviour, 5*, 241-280.

Larkin, J. H. (1989). What kind of knowledge transfers?. In L. B. Resnick (Ed.) *Knowing, Learning, and Instruction.* Hillsdale, NJ: Erlbaum Associates (pp. 283-305).

Lepper, M. R. (1985). Microcomputers in education: Motivational and social issues. *American Psychologists, 40*, pp. 1-18.

Lewis, C., & Norman, D. A. (1986). Designing for error. In D. A. Norman & S. W. Draper (Eds.), *User centered system design: New perspectives on human-computer interaction* (pp. 411-432). Hillsdale, NJ: Lawrence Erlbaum Associates.

Resnick, L. B. (1989). Introduction. In L. B. Resnick (Ed.) *Knowing, Learning, and Instruction*. Hillsdale, NJ: Erlbaum Associates (pp. 1-24).

Shneiderman, B. (1989). Designing the user interface. In T. Forester (Ed.), Computers in the human context. (pp. 166-173). Cambridge, MA: The MIT Press.

Singley, M. K., & Anderson, J. A. (1989). *The transfer of cognitive skill*. Cambridge, MA: The Harvard University Press.

Sternberg, R. J. (1989). Domain-generality versus domain-specificity: The life and impending death of a false dichotomy. *Merrill-Palmer Quarterly, 35*(1), 115-130.

Turkle, S. (1984). *The second self*. New York : Simon & Schuster.

Voss, J. F. (1989) Problem solving and the educational process. In A. Lesgold & R. Glaser (Eds.), Foundations for a psychology of education. (pp. 251-294). Hillsdale, NJ: Lawrence Erlbaum Associates.

Vygotsky, L. S. (1978). *Mind in Society*. Harvard University Press: Cambridge, MA.

Paper (M4.8b)
LOGO Research—Forward or Back?

Wing K. Au
University of Newcastle, Australia

Abstract

This paper reviews the research in programming with the computer language LOGO, in particular, the relationship of LOGO programming to the cognitive development of the learners. The first section provides a general overview about research in LOGO programming. This is then followed by a critical examination of the major types of LOGO research according to the outcome variables studied. A critical examination of the various issues pertaining to LOGO research, especially those of a cognitive nature, together with discussions of the major concerns and outcomes of these research will then be presented. The last section of this paper makes suggestions for future research.

Overview

It has been more than a decade since Professor Papert (1980) has extolled the virtues of LOGO in his book Mindstorms—that within a LOGO environment, learners can reflect upon their own thinking and take conscious control of the learning process by articulating and analyzing their own behaviour. Since then, LOGO has often been viewed by some educators as the magic of technology.

While LOGO has proved to be a popular educational computing language in elementary and junior high schools, increasing concern is being expressed about the validity of the claims of its developers (Au, Horton & Ryba, 1987). Teachers and researchers alike are beginning to question the effectiveness of LOGO as "an object to think with" and whether students actually derive any intellectual benefits from their LOGO experiences. Questions have been raised about the LOGO "curriculum" and how the teaching and learning environment should be organized for maximum effect.

Research on programming with LOGO is still in its early stages of development. Most of the initial research or "evidence", although indicating potential benefits for learners, are in the form of intuitive thinking or anecdotal in nature rather than based upon empirical research (c.f. Watt, 1982; Krasnor & Mitterer, 1984; Ginther & Williamson, 1985; Burton & Magliaro, 1986; Maddux & Johnson, 1988). The majority of these earlier research consist mainly of reports of teachers or researchers randomly observing individual or groups of students interacting with computers without systematic investigation or testing (e.g. Blitman, Jamile, & Yee, 1984; Chiang, Thorp, & Lubka, 1984). The results of this type of research, although useful as pilot studies of large scale projects, in the provision of rich descriptive data, and are at times "illuminating", are insufficient to provide convincing evidence.

More recent empirical studies available to date, although still limited in number and their scope to address the many broad claims that have been made about LOGO programming, seem to highlight the unresolved debate about potential cognitive gains within a LOGO environment, and in particular, the possible transfer of these gains from the LOGO context to others. Papert's claims, especially those of a cognitive nature, have been supported by some researchers (e.g. Gorman & Bourne, 1983; Clements, 1990; Au & Leung, 1991; Ortiz & MacGregor, 1991; Swan, 1991), but not by others (e.g. Pea, 1983; Chambers, 1986; Mitterer & Rose-Krasnor, 1986; Howell, Scott, Diamond 1987).

Such conflicting results are perhaps not surprising given the small number of subjects involved in some of the studies, and the types of research methods and analyses used. As well, a wide range of instruments were used in the assessment of the various outcome variables such as mathematical achievement, logical reasoning, and problem solving skills. Of particular importance to LOGO research is the issue of the type and/or amount of programming training provided, or the type of LOGO learning environment created for the subjects during the course of research (Leron, 1985; Au, Horton & Ryba, 1987; Papert, 1987; Rowe, 1991).

Types of LOGO research

Overall, in the last twenty years since the initial development of LOGO, research on the effects of LOGO programming can be grouped into five clusters according to the outcome variables examined in these studies. These clusters are: (i) mathematical learning; (ii) affective changes; (iii) social interaction; (iv) cognitive changes and their transfer to other contexts; and (v) metacognition.

LOGO programming and mathematical learning

Akin to one of the original notions that LOGO could be used to facilitate the development of mathematical learning among students, a number of studies have been conducted to examine the relationship between LOGO programming and mathematics learning. These studies, *inter alia,* examined mathematics related variables such as attitudes towards mathematics (Evans, 1984; Ortiz & MacGregor, 1991), learning and development of mathematical concepts (Howe, O'Shea & Plane, 1979; Schaefer & Sprigle, 1988), mathematical attainment (Finlayson, 1983; Battista & Clements, 1986), learning of mathematical strategies and their transfer from LOGO to normal school mathematics (Finlayson, 1985; Thompson & Chen Wang, 1988).

Studies on the relationship between LOGO programming and mathematical learning yielded some positive evidence that the learning of mathematics might be assisted by LOGO programming, especially in the fostering of positive changes among learners' attitude towards mathematics, and improving the understanding of some mathematical concepts. Researchers such as Schaefer and Sprigle (1988), and Noss (1987) suggest though, that in order for better development to occur, it is necessary to examine the use of instructional methods and careful teacher intervention strategies.

Results from studies on the transfer of learning of mathematics and strategies to normal classroom settings were less convincing. Seemingly, one of the major problems was that students failed to see the connection between what they learned and applications in other contexts. Consequently, some researchers suggested that instructions should make these connections explicit to the learners. Therefore, in researching the effects of LOGO programming on the transfer of mathematical strategies to normal classroom settings and mathematical attainment, it is important to consider the use of carefully orchestrated teacher intervention strategies so that learners can (i) become aware of the connections; and (ii) practise and internalize the strategies sufficiently so as to enable transfer. The issue of instructional strategies will be further discussed in a later section of this paper when LOGO treatment is considered.

LOGO programming and affective changes

Attribution theorists have argued that it would be important for learners to feel that they are in control of their learning environment (c.f. Weiner, 1974, 1979). In particular, it has been suggested better learning could be fostered by (i) the lack of external factors to which students might attribute success or failure, and (ii) learners being able to explore their learning without penalties for making mistakes (e.g. Ryba & Anderson, 1990). Papert (1980) contends that LOGO could provide such a learning environment.

The second major category of LOGO research revolves around the examination of the relationship between LOGO programming and the affective changes of learners. The variables examined in these research included: motivation (Weir, 1981; Zelman, 1985; Nastasi, Clements & Battista, 1990); locus of control (Horner & Maddux, 1985; Burns & Hagerman, 1989); and attitudes towards computing and the learners themselves (Irwin, 1985; Schibeci, 1990).

The results of these studies offered reasonable support that LOGO programming could have a facilitative effect on motivation, internalization of locus of control and attitude of learners towards computers and problem solving. Of particular interest was the fact that two different types of LOGO learning environments were employed in research in this category, that is, the use of self discovery learning environment (e.g. Evans, 1984; Lehrer, Harckham, Archer & Prazek 1986) and more structured learning environment (e.g. Nastasi, Clements & Battista, 1990). It would appear on the surface that both types of learning environments were able to facilitate positive affective changes among the learners. However, studies by Zelman (1985), and Nastasi, Clements and Battista (1990) clearly suggest that a purely self discovery learning environment was not sufficient to develop intrinsic motivation and self reward system for the learners, rather, carefully designed teacher intervention would be needed. The issue of learning environment will be discussed further in a later section of this paper.

LOGO programming and social interaction

The investigation of social interactions within educational environments has been considered important. Apart from being one of the fundamental goals of education, it has also been argued that social interaction is an essential component that facilitates cognitive growth (c.f. Vygotsky, 1978; Emihovich & Miller, 1986; Salomon, 1988; Nastasi, Clements & Battista, 1990). According to Vygotsky (1978), higher order mental capabilities progress from external to internal processes, and that the mechanisms underlying the internalization of higher mental functions is social interaction. Emihovich and Miller (1986) contend that the transformation process from externalization to internalization occurs as children engage in meaningful mediated verbal interactions with adults and/or peers during LOGO learning.

The third major category of LOGO research focused on the relationship between LOGO programming and social interaction. A number of variables were examined: peer interactions (Hawkins, Homolsky & Heide, 1984; Carmichael, Burnett, Higginson, Moore, & Pollard, 1985; Burns & Coon, 1990); interaction and problem solving (Clements & Nastasi, 1988; Nastasi, Clements & Battista, 1990); effects of group size (Guntermann & Tovar, 1987); interactions of parents and children (Williamson & Silvern, 1986); behaviours of learners (Mitterer & Rose-Krasnor, 1986); and gender differences (Webb, 1985; Guntermann & Tovar, 1987; Hoyles & Sutherland, 1989).

The studies on the relationship between LOGO programming and social interactions have offered some evidence that LOGO programming could influence social interactions among learners (e.g. Williamson & Silvern, 1986; Clements & Nastasi, 1988; King, 1989). Some of these studies have stressed the importance of social interaction in the aid of cognitive development. However, none of these studies have managed to illustrate whether the increased interaction was the result of the LOGO programming language alone, or the result of some instructional variables working in conjunction with the LOGO language. Future studies, therefore, must attempt systematically to identify the effects of individual instructional variables engendered in a LOGO environment on the type of social interactions ensued, and how these social interactions might in turn affect the problem solving performance of the subjects. Moreover, one of the major criticisms of much contemporary research on LOGO stems from the fact that many studies only focused on the end products of learning, that is, how LOGO has affected product variables such as mathematical learning and cognitive changes (c.f. Papert, 1987; Rowe, 1991). It was suggested by many researchers that it is important to examine the changes in process variables such as social interaction and learning strategies.

LOGO programming and cognitive changes

While a number of studies have been conducted to examine the relationship between LOGO programming and variables such as mathematics learning, affective changes, and social interaction, the vast majority of LOGO research in the last twenty years, in particular, the 1980's and early 1990's, focused on LOGO programming and cognitive changes. Most of these studies were conducted in response to claims made by Papert and others that LOGO programming could facilitate learners' general cognitive development and assist the transfer of learning from a LOGO environment to other contexts. Some of these studies attempted to investigate the correlation between various factors related to the learning of programming. These studies included the examination of the relationship between: programming and understanding of the concept of recursion (Pea & Kurland, 1984); mastery of programming and operational thinking (Mendelsohn, 1987); LOGO programming and top-down processing, field independence, holistic tendency, and academic achievement (Bradley, 1985); competence with the syntax and semantics of the LOGO language (Campbell, Fein, Scholnick, Frank, Schwartz, 1986); analogical reasoning and writing subprocedures and use of variables (Clement, Kurland, Mawby, & Pea, 1986); mastery of programming concepts (Cohen, 1987); cognitive development and understanding of LOGO commands (Fay & Mayer, 1987); and extended workstations and learning of programming (Heller, 1991).

However, the majority of studies within this category are of a causal nature, i.e., how the learning of LOGO programming could effect certain cognitive outcomes. Three major types of research could be discerned from studies within this cluster depending on the outcome variables studied— (i) global changes in the cognitive development; (ii) improvement of logical reasoning abilities; and (iii) development of problem solving skills and their transfer to other contexts. Whilst the three different types of research are inevitably closely linked, their different emphases warrant separate discussion.

The studies on global changes in cognitive development have shown that LOGO programming might be facilitative in certain areas such as cognitive style and spatial orientation. However, LOGO programming might not be able to alter significantly the general cognitive development of young children, even with reasonably long period of learning (e.g. Howell et *al*, 1987), or by carefully orchestrated teacher intervention (e.g. Clements & Gullo, 1984). Perhaps the training periods of these studies were not quite long enough to produce the results that many LOGO enthusiasts have hypothesized. On the other hand, it is quite plausible that learning resulting from LOGO programming might be too specific to be transferred to a more general context assessed by Piagetian conservations tasks and the other dependent measures used. The results of these studies tend to lend support to Piagetian theory which would predict that normal developmental factors would dictate the movement of children from one stage to another.

Some studies which focussed on logical reasoning offered modest support that LOGO programming might assist the development of logical reasoning among learners (e.g. Gorman & Bourne, 1983; Reiber, 1983; Degelman, Free, Scarlato, Blackburn & Golden, 1986; Many, Lockard & Abrams, 1988) while others were inconclusive (Grandgenett & Thompson, 1991). However, given the number of flaws in some of these studies such as small samples, doubtful statistical analyses, and lack of pre-post comparisons (c.f. Au, 1992), their results must be viewed with caution. Future studies need to exercise tighter control on a number of research design elements: (i) the use of larger number of subjects to enable statistically valid comparison; (ii) the establishment of whether there is any difference in the subjects' logical reasoning prior to intervention; and (iii) closer examination of the possible effects of instructional variables such as teacher mediation and peer interaction, which might influence the development of logical reasoning skills.

Given the strong emphasis on problem solving in modern education, a large number of LOGO studies have focussed on problem solving. However, the results to date have been rather inconclusive. Some studies have found that LOGO programming could facilitate the development and transfer of problem solving skills (e.g. Gallini, 1987; Lehrer & Randle, 1987; Mathinos, 1990; Au & Leung, 1991; Swan, 1991) while others have found results to the contrary (e.g. Pea, 1983; Chambers, 1986; Kurland et *al*, 1986; Mitterer & Rose-Krasnor, 1986).

In examining these studies, a number of factors were found to have contributed to such conflicting results. The first factor relates to the measurement of outcome variables. It is apparent that a wide variety of measures were employed to determine how LOGO programming might have affected the development of problem solving skills. Consequently, such variation of instruments led to the apparently conflicting results. The multitudes of measures used in gauging the changes of problem solving skills could be traced to the theoretical bases upon which these studies were formulated.

Measurement of outcome variables

One of the most striking problems with research involving LOGO programming and problem solving is the general lack of theoretical basis for the studies (c.f. Burton & Magliaro, 1986; Clements, 1990). This problem has resulted in the lack of any anchor points to relate the findings with the literature, and difficulty in the selection of dependent measures and corresponding instruments, particularly in the determination of transfer of problem solving skills to other contexts.

Some studies did not identify the types of problem solving skills that were supposed to be observed during the learning of LOGO programming. Instead, these studies relied solely on teachers' anecdotes or students' self reports on the development and transfer of problem solving skills without using any systematic measurements (e.g. Carmichael et *al*, 1985).

Some studies, on the other hand, attempted to use a large number of dependent measures of problem solving in the hope of "catching" problem solving skill development and transfer. For instance, in the study by Clements and Gullo (1984), 18 dependent measures such as cognitive style, metacognition, cognitive development, and directionality were used. Although the use of these measures were well grounded in theories of cognition and problem solving, it is rather debatable whether such a large number of skills could be expected to develop within a relatively short duration of LOGO programming.

Some other studies even arbitrarily used dependent measures without examining closely the relationship between LOGO programming and the dependent measures. Often dependent measures were used without appropriate rationale which often gave rise to conflicting results. This has resulted in what Burton and Magliaro (1986) have termed as a "kitchen sink" approach. For example, a study by Soloway, Lockhead, and Clement (1982) investigated programming effects on problem solving without any reference to the problem solving literature. Khayrallah and Meiraker (1987) suggest that this lack of proper theoretical underpinning has resulted in an approach that focuses on testing what works and does not work, rather than attempting to specify the underlying processes that might determine success or failure.

Against this background, a number of researchers have alerted to the development of "technocentric thinking" among some researchers and educators. Papert (1987), for instance, cautions that this approach represents a tendency in thinking of LOGO as an agent that acts directly on thinking and learning. Rowe (1991) argues that computers are far more than just a treatment, that they have become inextricably intertwined not only with the way students might go about cognitive tasks, but with the whole context of learning and teaching. In relation to the selection of dependent variables, researchers need to examine critically the types of problem solving skills that learners might develop while learning to program with the LOGO language. Once the type of skills have been identified, then care needs be exercised in the justification of the choice of dependent measures on both theoretical and practical bases. At a theoretical level, it is important to consider the issue of transfer of learning to other domains. Moreover, many researchers have argued for the importance of measuring the success of LOGO learning via task and strategy oriented variables rather than the traditional product oriented measurements (King, 1989; Burns & Coon, 1990; Swan, 1991). At a practical level, it is important to deliberate the extent to which problem solving skills might be developed within the time limits of most studies. Given the generally short duration of many LOGO studies, it is useful to focus on instructional conditions that would foster the development of a smaller number of problem solving skills among the learners in a more intensive manner.

Research design

The second concern relates to the design of this type of research: researchers must not neglect the most important components of learning situations, *viz*, people and cultures—in the facilitation of learning. That when researching LOGO programming and problem solving, attention needs be given to the examination and evaluation of the programming culture as well as the use of psychometric instruments to measure any potential cognitive gains (d.f. Papert, 1987; Rowe, 1991). For instance, the dynamics of learning with LOGO in either small groups or individually, and the qualitative changes among the learners might not be measured by traditional psychometric instruments.

Some of the earliest LOGO research relied heavily on anecdotal evidence without being able to provide convincing evidence. Some of the studies on LOGO and problem solving conducted in the early 1980's attempted to overcome this problem by employing more traditional experimental design. A typical study of this kind would pretest the subjects, introduce the subjects to LOGO programming, then posttest them to find if there were any gains in problem solving skills.

The use of this type of research design has raised serious concerns among many LOGO researchers and there has been debate conducted regarding the suitability of such design (c.f. Leron, 1985; Becker, 1987; Pea, 1987; Papert, 1987; Walker, 1987; McDougall, 1988; Rowe, 1991). It has been argued by some researchers that the traditional experimental design was not sufficiently sophisticated to measure potential cognitive gains of the learners. Rather, it is important to examine the process of learning including the dynamics of learning as well as the product measured via psychometric instruments (Leron, 1985; Papert, 1987; McDougall, 1988; Rowe, 1991).

More recent studies in the late 1980's have taken such concern into consideration and often attention has been given to the study of interactions among the learners that might have affected any cognitive outcomes of such studies. Some studies have begun to examine more closely the type of interactions that might have contributed to the changes in problem solving skills of the learners and what the learners might have gained during the processes of learning to program with LOGO. For example, Clements and Nastasi (1988) studied 24 first graders and found that the LOGO group exhibited a significantly higher percentage of social behaviours that have cognitive underpinning. The study by Nastasi, Clements and Battista (1990) found that their LOGO group evinced more cognitively oriented conflict, attempts at and successful resolution of conflicts, and rule making.

As well, there has been an increasing awareness of the need to control the instructional conditions that might facilitate cognitive growth. Recent studies (Lehrer, Guckenberg, & Lee, 1988; Au & Leung, 1991; Dalton & Goodrum, 1991; Heller, 1991; Ortiz & MacGregor, 1991; Swan, 1991;) have all employed research designs that enabled these studies to examine the effects of various instructional conditional on the development of problem skills among their subjects.

LOGO instructions

The third concern relates to the nature of LOGO instruction, in particular, those elements that might have affected the transfer of problem solving skills. The inconclusive results of early LOGO studies on problem solving, and other areas, have prompted many researchers to examine more closely the types of LOGO instructions provided for learners during the learning of LOGO programming. In particular, it has been advanced that the use of more explicit instructions in problem solving might be facilitative in the development of problem solving skills and the transfer of these skills to other contexts (Leron, 1985; Au, Horton & Ryba, 1987).

Recent LOGO studies since the middle of 1980's that incorporated explicit instructions in problem solving (e.g. Miller & Emihovich, 1986; Au & Leung, 1991; Ortiz & MacGregor, 1991; Swan, 1991) and metacognitive training (e.g. Clements, 1987; Clements, 1990) have clearly highlighted the potential benefits of such exploitation of instructional conditions in the improvement and transfer of problem solving skills of learners.

LOGO programming and metacognitive skills

Within the field of educational computing, there has been an increasing attention on the development of higher order thinking skills (e.g. Au & Bruce, 1990; Lai, 1990), as well as the link between computer science and metacognitive functioning (Haller, Child & Walberg, 1988; Salomon, Perkins & Globerson, 1991). Papert advocated in his seminal work Mindstorms that LOGO could be used to teach learners to think about thinking (Papert, 1980). Some researchers have also argued that the characteristics of the LOGO language could assist learners to develop metacognitive skills (c.f. Lariv_e *et al*, 1988). As a result, a number of studies have focused on the relationship between LOGO programming and metacognition since the middle of 1980's. A main aim of these studies was to establish whether the experience of LOGO programming could enhance the development of metacognitive skills, and how such experience might facilitate the improvement of problem solving. The results of these studies have been rather encouraging. It is apparent that the metacognition of the subjects improved after learning to program with LOGO (e.g. Clements & Gullo, 1984; Lehrer & Randle, 1987). Also, the performance in problem solving was also enhanced (e.g. Clements, 1990). Future studies would benefit though by clearly outlining the effects of instructions and how instructions might increase the opportunities for the development of metacognition. As well, efforts will need to be made to establish how the improvement in metacognition would benefit the development of problem solving skills.

Major concerns of LOGO research

Having reviewed a sample of LOGO studies according to their outcome variables, a number of concerns emerged. The most important of them is the type of LOGO treatment offered to the subjects. It has become quite clear that the type of LOGO treatment played a significant role in determining the outcomes of research in LOGO. Other concerns include the selection of sample and the type of research methods and analyses used. The following sections will examine these concerns in more details.

LOGO treatment

It has been suggested by many educational computing researchers that the issue of treatment is a crucial concern in programming language and problem solving research (c.f. Thomas, 1986; Palumbo, 1990; Seidman, 1990-91; Grandgenett, 1991; Au, 1992). Based on this premise, it is reasonable to expect that the type of LOGO instruction and length of treatment would play a vital role in determining the outcomes of programming instructions. The issue of LOGO treatment, in particular, the type of LOGO instruction, has been at the centre of debate in LOGO research, especially during the 1980's when researchers started to examine how various instructional variables might influence the outcomes of programming instructions.

In examining the various studies on LOGO programming, it is apparent that there is a lack of clarity in the meaning of "LOGO programming" and the level of mastery attained by the subjects. Some of the reports on LOGO research either provided little or no description of the type of "LOGO treatment" for the subjects (e.g. Gallini, 1987; Schibeci, 1990). In these reports, it was often accounted that subjects learned LOGO programming, or were exposed to some LOGO experience, for a certain period of time, without specifying what that experience was, and how it might have affected the outcome variables. Of the reports that delineated the kinds of LOGO experience provided for the subjects, often either one of the following pedagogical approaches was used. Some researchers adopted the use of a self-discovery learning environment, devoid of any teacher intervention, while others used carefully constructed teacher mediation.

LOGO instructions

The types of instructions used in LOGO research reflect a much wider concern in pedagogy. Some educators have supported a self-discovery model in learning. This model is often based on the Piagetian model of knowledge acquisition, which suggests that knowledge can best be acquired through self-discovery learning (Piaget, 1976). In other words, learners learn best by being placed in an environment where they can interact and participate in their own self directed manner. A number of LOGO researchers, notably Seymour Papert and his colleagues at the Massachusetts Institute of Technology, have adopted this model in their creation of a LOGO learning environment. Following this model, the experience provided for the learners was of a spontaneous and undirected manner.

This approach has also been adopted by a number of researchers in their studies (see Appendix 1). However, this type of research often failed to produce the anticipated cognitive effects espoused by Papert and others (c.f. Palumbo, 1990). Therefore, at the conclusion of some of these studies, many researchers (e.g Pea & Kurland, 1987; Schaefer & Sprigle, 1988; Thompson & Chen Wang, 1988) suggested that it would be important to consider conscious and careful intervention strategies.

Other LOGO researchers have adopted a more structured approach in programming instruction with carefully designed mediation. They believe that LOGO programming alone cannot achieve what Papert has claimed. Rather, if the learners were to develop some form of cognitive and problem solving skills, then some type of deliberate intervention must be implemented. This approach is clearly exemplified in some of the earlier research conducted at the University of Edinburgh (e.g. Howe, O'Shea & Plane; Finlayson, 1983, 1985). Recently, there has been an increasing number of research that employed a more structured pedagogical approach in LOGO instructions, e.g., those conducted at the University of Ohio (Clements & Gullo, 1984; Clements, 1986; Clements & Nastasi, 1988; Clements, 1990; Nastasi, Clements & Battista, 1990), and many others (Lehrer, Guckenberg, & Lee, 1988; Au & Leung, 1991; Heller, 1991; Ortiz & MacGregor, 1991; Swan, 1991).

One of the important factors that clearly underpins the different types of intervention strategies in LOGO instructions relates to the roles that teachers play in a LOGO environment. There has been a continuing debate about the role of teachers in LOGO instruction but until recently, little empirical research has been conducted to offer teachers guidelines on the best ways to use LOGO in the classrooms (Khayrallah & Meiraker, 1987).

This debate has been further complicated by Papert's own work. In his book Mindstorms, Papert (1980) advocates "learning without curriculum", and yet he also argues that the teacher should act as an anthropologist and support the students as they build their own intellectual structures. Often, one of the central issues in the consideration of "LOGO instruction" is to resolve Papert's seemingly conflicting notion over the teacher's role in a discovery learning environment in order for children to make the cognitive gains through the use of LOGO as outlined in Mindstorms. It was perhaps because of this lack of clarity and direction of how LOGO should be used that has resulted in some researchers adopting a narrow interpretation of Papert's discovery-learning approach which is devoid of any teacher intervention.

Other researchers though, argue for the importance of teacher intervention in a LOGO environment (e.g. Pea, 1983; Leron, 1985; Au, Horton & Ryba, 1987), including the need to make explicit to the learners of the type of problem solving processes (e.g. Clarke & Chambers, 1984; Nolan & Ryba, 1986) and the incorporation of metacognitive training (e.g. Lehrer & Randle, 1987; Au & Leung, 1991) which will facilitate cognitive gains and the transfer of learning. Results of more recent research that adopted systematic teacher intervention have lent further support to such arguments (e.g. Clements, 1990).

Length of treatment

Another related factor that could explain the discrepancies of results with LOGO research is the length of "LOGO treatment". In examining the various studies related to LOGO programming, it is apparent that there has been a large variation in the length of LOGO treatment for the subjects, ranging from three 30 minute sessions (e.g. Cuneo, 1986) to an hour a week for one or two school years (e.g. Weir, 1981; Noss, 1987).

Arguably, this extensive variation in the duration of LOGO treatment had contributed to the discrepancies in the results of these research. While it is difficult to suggest what constitutes sufficient or optimal LOGO training for the students, it is reasonable to contend that the length of LOGO treatment is directly related to the level of mastery of LOGO programming, which might in turn influence the measures of the outcome variables such as problem solving skills development and transfer.

Level of mastery

Researchers such as Pea and Kurland (1987), Dalbey and Linn (1985), and Khayrallah & Meiraker (1987) have repeatedly called for the examination of the relationship between the level of mastery of programming and the cognitive consequences of programming learning including the transfer of learning to other knowledge domains. Linn (1985), Leron (1985), and Palumbo (1990) have outlined a chain of cognitive accomplishment through the learning of programming (Figure 1).

These researchers, *inter alia*, have argued that there are stages that a student must go through, and that the level of programming abilities a student has mastered would be a predictor of the kinds of concepts and skills that the student will transfer beyond programming. In particular, Pea and Kurland (1984) and Dalbey and Linn (1985) has argued that cognitive gains and transfer are related to the mastery of programming

While it is quite debatable whether a learner might not encounter metacognitive experience or develop metacognitive knowledge while working at the first and the second levels, it is clear that from these models that the higher the level reached by the learners, the more probable that transfer of learning would occur. In order to increase the likelihood of transfer of learning, it would be advisable to increase the incidence of metacognitive experience even during the early stages of learning of LOGO. Also, the direct teaching of metacognitive knowledge may be another way to facilitate transfer of learning.

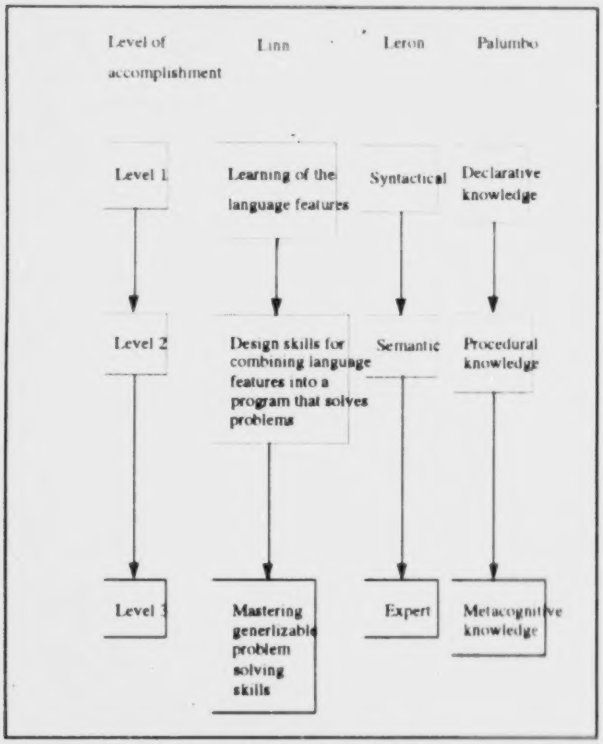

Level of accomplishment
Linn
Leron
Palumbo
Level 1
Learning of the language features
Syntactical
Declarative knowledge
Level 2
Design skills for combining language features into a program that solves problems
Semantic
Procedural knowledge
Level 3
Mastering generlizable problem solving skills
Expert
Metacognitive knowledge

Figure 1. Chain of cognitive accomplishment

Selection of sample

In reviewing a substantial number of research in LOGO, there emerged a number of concerns related to the selection of sample. These concerns are: (i) small number of subjects used in some studies; (ii) the non-random selection of subjects; and (iii) the appropriateness of selection of subjects.

Apart from many case-studies which observed only a very small number of students, some studies, owing to their nature, tended to use small number of subjects (e.g. studies with physically handicapped students). However, there are a number of studies which used fairly small numbers of subjects in typical experimental studies (e.g. Gorman & Bourne, 1983; McAllister, 1985; Miller & Emihovich, 1986). The use of small number of subjects in such studies clearly warrant caution in interpreting their results.

A second concern is the non-random selection of subjects in some of these studies. Owing to possible ethical and logistical constraints or otherwise, some studies did not select their subjects randomly (e.g. Noss, 1987; Schaefer & Sprigle, 1988). The non-random selection of subjects and allocation to groups, and the lack of statistical control to compensate, clearly reflects a concern in the use of experimental studies.

A third concern relates to the selection of samples of the appropriate age range for optimal training and benefit. Current research on LOGO have selected samples ranging from preschool to adults. A question that needs be addressed is: what age group of subjects are likely to benefit from programming instruction in LOGO?

Some researchers have argued that students at the concrete operational stage of cognitive development are unlikely to improve significantly in higher order thinking skills, and hence unlikely to benefit from problem solving skills instruction through the learning of programming (c.f. Piaget, 1977; Palumbo, 1990). However, such argument apparently runs contrary to what Papert has advocated in Mindstorms—that LOGO can concretize the abstract—implying that children's transition from the concrete operational stage to formal operational thinking could be expedited by the learning of LOGO programming.

One of the reasons that has been advanced was that younger children have not had sufficient exposure to a variety of problem solving domains, therefore, it would be unlikely for transfer of learning to occur. If that is the case, then future research with LOGO need to address such issue by providing students with more exposure in different problem solving situations in order to increase the likelihood of transfer of problem solving skills.

Research design

The last major issue relates to the research design used in a number of LOGO studies. Four major concerns can be identified in this section: (i) use of control group; (ii) use of traditional experimental design; (iii) equivalence of training; and (iv) social interaction while learning LOGO. The second and fourth concerns have been discussed in an earlier section of this paper and hence will not be repeated here. The following section will examine the other two concerns.

A number of studies (e.g. Mayer & Fay, 1987; Schibeci, 1990), while using traditional experimental design, failed to use a control group. Without the use of a control group, these studies could not ascertain whether the observations were the results of LOGO's influence only.

Another major problem inherent with many of the studies reviewed relates to the equivalence of training provided for the various groups of subjects. Quite often, researchers would provide "LOGO training" for the experimental groups and "other methods" such as CAI or "normal mathematic classes" for the controls. This type of design often posed difficulty in determining the equivalence of the various kinds of training for

BEST COPY AVAILABLE

the subjects. Therefore, careful consideration must be given to the use of comparison groups in future studies.

Summary and conclusion

This paper has reviewed a number of LOGO studies and highlighted some of the major concerns of LOGO research. One of the main concerns is that the teaching and learning of LOGO has been interpreted differently by different investigators. In some studies, a purely discovery approach has been adopted whereas on the other hand, a number of studies has used various forms of teacher intervention. Although studies that utilized teacher intervention seemed to yield more consistent results in assisting learners in their cognitive development, the effectiveness of instructional approaches used in the teaching of LOGO still remained unclear. In particular, much work remain to be done in identifying instructional approaches that may assist the transfer of problem solving skills to other domains.

The second major concern lies in the measurement of problem solving skills and their transfer to other domains. Few studies have taken into consideration of the need to identify the type of transfer that may take place after learning LOGO programming, and how such transfer could be measured.

The third major concern relates to the social interactions of learners while learning to program with LOGO. Few studies have attempted to measure nor control the type of social interactions that might have influenced the problem solving skills of learners.

In order to address these three major issues, future studies on LOGO programming need to turn to the literature in problem solving and metacognition for further guidance in the development of problem solving skills in relation to the learning of LOGO. It is not sufficient to just talk about a "LOGO environment or microworld", rather, it is important to examine more closely the various instructional, cultural, social and human elements within such an environment. Research with LOGO programming has "FORWARDED a large number of steps" in the last twenty years. However, future research will need to further address some of the major issues discussed in this paper.

References

Au, W.K. (1992). *LOGO programming: Problem solving and instruction methods.* Unpublished Ph.D. thesis. Palmerston North, New Zealand: Massey University.

Au, W.K., & Bruce, M. (1990). Using Computers in Special Education. *Journal of Remedial Education, 22*(1-2), 13-18.

Au, W.K., Horton, J. & Ryba, K. (1987). LOGO, teacher intervention, and the development of thinking skills. *The Computing Teacher, 15*(3), 12-16.

Au, W.K., & Leung, J.P. (1991). Problem solving, instructional methods, and LOGO programming. *Journal of Educational Computing Research, 17*(4), 455-467.

Battista, M. & Clements, D. (1986, April). *The effects of LOGO and CAI problem-solving environments on elementary students' problem-solving processes and mathematics achievement.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Becker, H.J. (1987). The importance of a methodology that maximizes falsifiability: Its applicability to research about Logo. *Educational Researcher, 16*(5), 11-16.

Blitman, E., Jamile, B., & Yee, D. (1984). Computers, children and epistemology. *Educational Perspectives, 22*(4), 16-20.

Bradley, C.A. (1985). The relationship between students' information-processing styles and LOGO programming. *Journal of Educational Computing Research, 1*(4), 427-394.

Burns, B., & Coon, H. (1990). LOGO programming and peer interactions: An analysis of process- and product-oriented collaborations. *Journal of Educational Computing Research, 6*(4), 393-410.

Burns, B., & Hagerman, A. (1989). Computer experience, self-concept and problem-solving: The effects of LOGO on children's ideas of themselves as learners. *Journal of Educational Computing Research, 5*(2), 199-212.

Burton, J.K., & Magliaro, S.G. (1986, April). *Computer programming and generalized problem solving skills: a critical review of the literature.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Campbell, P.F., Fein, G.G., Scholnick, E.K., Schwartz, S.S., Frank, & R.E. (1986). Initial Mastery of the Syntax and Semantics of LOGO. *Journal of Educational Computing Research, 2*(3), 357-378.

Carmichael, H.W., Burnett, J.D., Higginson, W.C., Moore, B.G., & Pollard, P.J. (1985). *Computers, children, and classrooms: A multisite evaluation of the creative use of microcomputers by elementary school children.* Ontario: Queen's Printer for Ontario.

Chambers, S.M. (1986). So Papert was right?: Evidence of general skills enhancement due to LOGO experience. In A.D. Salvas & C. Dowling (Eds.). *On the crest of a wave?* (pp. 261-264). Balaclava, Victoria: Computer Education Group of Victoria.

Chiang, B., Thorpe, H.W., & Lubke, M. (1984). LD students tackle the LOGO language: strategies and implications. *Journal of Learning Disabilities, 17*(5), 303-304.

Clarke, V.A., & Chambers, S.M. (1984). Developing LOGO activities for the primary classroom. In A.D. Salvas (Ed.), *Computing and education—1984 and beyond,* (pp. 309-312). Balacava: Computer Education Group of Victoria.

Clement, C.A., Kurland, D.M., Mawby, R., & Pea, R.D. (1986). Analogical reasoning and computer programming. *Journal of Educational Computing Research, 2*(4), 473-486.

Clements, D.H. (1987). Longitudinal study of the effects of LOGO programming on cognitive abilities and achievement. *Journal of Educational Computing Research, 3*(1), 73-94.

Clements, D.H. (1990). Metacomponential development in a LOGO programming environment. *Journal of Educational Psychology, 82*(1), 141-149.

Clements, D.H., & Gullo, D.F. (1984). Effects of computer programming on young children's cognition. *Journal of Educational Psychology, 76*(6), 1051-1058.

Clements, D.H., & Nastasi, B.K. (1988). Social and cognitive interactions in educational computer environments. *American Educational Research Journal, 25*(1), 87-106.

Cohen, R. (1987). Implementing LOGO in the grade two classroom: Acquisition of basic programming concepts. *Journal of Computer-Based Instruction, 14*(4), 124-132.

Cuneo, D.O. (1986, April). *Young children and turtle graphics programming: generating and debugging simple turtle programs.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Dalbey, J., & Linn, M.C. (1985). The demands and requirements of computer programming: A literature review. *Journal of Educational Computing Research, 1*(3), 253-274.

Dalton, D.W., & Goodrum, D.A. (1991). The effects of computer programming on problem-solving skills and attitudes. *Journal of Educational Computing Research, 7*(4), 483-506.

Degelman, D., Free, J.U., Scarlato, M., Blackburn, J.M., & Golden, T. (1986). Concept learning in preschool children: effects of a short-term Logo experience. *Journal of Educational Computing Research, 2*(2), 199-205.

Emihovich, C., & Miller, G.E. (1986, April). *Verbal mediation in Logo instruction: learning from a Vygotskian perspective.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Evans, H.R. (1984). *Some effects of LOGO programming instruction with fourth grade children.* Unpublished doctoral dissertation. Virginia: University of Virginia.

Fay, A.L., & Mayer, R.E. (1987). Children's naive conceptions and confusions about LOGO graphics commands. *Journal of Educational Psychology, 79*(3), 254-268.

Finlayson, H.M. (1983). *The development of mathematical thinking through LOGO. D.A.I. Research paper no. 205.* Paper presented to the British LOGO User's Group conference, September, 1983.

Finlayson, H.M. (1985). *The transfer of mathematical problem solving skills from LOGO experience.* D.A.I. Research paper no. 238. Paper presented to the World Conference of Computers in Education, Norfolk, Virginia, 1985.

Gallini, J.K. (1987). A comparison of the effects of LOGO and a CAI learning environment on skills acquisition. *Journal of Educational Computing Research, 3*(4), 461-477.

Ginther, D.W., & Williamson, J.D. (1985). Learning LOGO: What is really learned? *Computers in the Schools, 2*(2/3), 73-78.

Gorman, H. Jr., & Bourne, L.E. Jr. (1983). Learning to think by learning LOGO: rule learning in third-grade computer programmers. *Bulletin of the Psychonomic Society, 21*(3), 165-167.

Grandgenett, N. (1991). Using LOGO programming to teach analogical reasoning in science and mathematics education. *Journal of Computers in Mathematics and Science Teaching, 10*(3), 29-36.

Grandgenett, N., & Thompson, A. (1991). Effects of guided programming instruction on the transfer of analogical reasoning. *Journal of Educational Computing Research, 7*(3), 293-308.

Guntermann, E., & Tovar, M. (1987). Collaborative problem-solving with LOGO: Effects of group size and group composition. *Journal of Educational Computing Research, 3*(3), 313-334.

Haller, E.P., Child, D.A., & Walberg, H.J. (1988). Can comprehension be taught? A quantitative synthesis of "metacognitive" studies. *Educational Researcher, 17*(9), 5-8.

Hawkins, J., Homolsky, M., & Heide, P. (1984). *Paired problem solving in a computer context. Technical report No. 33.* N.Y.: Bank Street College of Education, Center for Children and Technology.

Heller, R.S. (1991). Toward a student workstation: extensions to the LOGO environment. *Journal of Educational Computing Research, 7*(1), 77-88.

Horner, C.M., & Maddux, C.D. (1985). The effects of LOGO on attributions toward success. Computers in the Schools, 2(2/3), 45-54.

Howe, J.A.M., O'Shea, T., & Plane, F. (1980). Teaching mathematics through LOGO programming: an evaluation study. In R. Lewis & D. Tagg (Eds.) *Computer assisted learning scope, progress and limits* (pp. 85-102). Amsterdam, Holland: North Holland.

Howell, R.D., Scott, P.B., & Diamond, J. (1987). The effects of "instant" LOGO computing language on the cognitive development of very young children. *Journal of Educational Computing Research, 3*(2), 249-260.

Hoyles, C., & Sutherland, R. (1989). *Logo mathematics in the classroom.* London: Routledge.

Irwin, K. (1985, August). *Form II children working with LOGO and Basic.* Paper presented to the First National Conference of the New Zealand Computer Education Society, Auckland.

Khayrallah, M.A., & van den Meiraker, M. (1987). LOGO programming and the acquisition of cognitive skills. *Journal of Computer-Based Instruction, 14*(4), 133-137.

King, A. (1989). Verbal interactions and problem-solving within computer-assisted cooperative learning groups. *Journal of Educational Computing Research, 5*(1), 1-15.

Krasnor, L., & Mitterer, J. (1984). LOGO and the development of general problem solving skills. *The Alberta Journal of Educational Research, 30*(2), 133-144.

Kurland, D.M, Pea, R.D., Clement, C., & Mawby, R. (1986). A study of the development of programming ability and thinking skills in high school students. *Journal of Educational Computing Research, 2*(4), 429-458.

Lai, K. (1990). Problem solving in a Lego-Logo learning environment: Cognitive and metacognitive outcomes. In A. McDougall & C. Dowling (Eds.) *Computers in Education* (pp. 403-408). Amsterdam: North-Holland.

Lariv_e, S., Parent, S., Dupr_, S., & Michaud, N. (1988). Programming Logo, cognition and metacognition. *Canadian Journal of Special Education, 4*(1), 49-77.

Lehrer, R., & Randle, L. (1987). Problem solving, metacognition and composition: The effects of interactive software for first-grade children. *Journal of Educational Computing Research, 3*(4), 409-427.

Lehrer, R., Guckenberg, T., & Lee, O. (1988). Comparative study of the cognitive consequences of inquiry-based Logo instruction. *Journal of Educational Psychology, 80*(4), 543-553.

Lehrer, R., Harckham, L.D., Archer, P, & Pruzek, R.M. (1986). Microcomputer-based instruction in special education. *Journal of Educational Computing Research, 2*(3), 337-355.

Leron, U. (1985). LOGO today: Vision and reality. *The Computing Teacher, 12*(5), 26-32.

Linn, M.C. (1985). The cognitive consequences of programming instruction in classrooms. *Educational Researcher, 14*(5), 14-16, 25-29.

Maddux, C.D., & Johnson, D.L. (1988). *LOGO: Methods and curriculum for teachers.* N.Y.: The Haworth Press.

Many, W.A., Lockard, J., & Abrams, P.D. (1988). The effect of learning to program in Logo on reasoning skills of junior high school students. *Journal of Educational Computing Research, 4*(2), 203-213.

Mathinos, D.A. (1990). LOGO programming and the refinement of problem-solving skills in disabled and nondisabled children. *Journal of Educational Computing Research,* 6(4), 429-446.

McAllister, A. (1985). *Problem solving at the threshold of computer programming (Bulletin No. 13).* Toronto: Toronto Board of Education.

McDougall, A. (1988). *Children, recursion and Logo programming.* Unpublished Ph.D. thesis. Melbourne: Monash University.

Mendelsohn, P. (1987). L'apprentissage des concepts informatiques: du d_placement de la tortue LOGO _ la coordination d'objets graphiques. *Revue Canadienne de Psycho-_ducation, 16*(2), 97-118.

Miller, G.E., & Emihovich, C. (1986). The effects of mediated programming instruction on preschool children's self-monitoring. *Journal of Educational Computing Research, 2*(3), 283-297.

Mitterer, J., & Rose-Krasnor, L. (1986). LOGO and transfer of problem solving: an empirical test. *The Alberta Journal of Educational Research, XXXII*(3), 176-194.

Nastasi, B.K., Clements, D.H., & Battista, M.T. (1990). Social-cognitive interactions, motivation, and cognitive growth in LOGO programming and CAI problem-solving environments. *Journal of Educational Psychology, 82*(1), 150-158.

Nolan, C.J.P., & Ryba, K. (1986). *Assessing learning with LOGO.* Eugene: International Council of Computers in Education.

Noss, R. (1987). Children's learning of geometrical concepts through LOGO. *Journal for Research in Mathematics Education, 18*(5), 343-362.

Ortiz, E. & MacGregor, S.K. (1991). Effects of LOGO programming on understanding variables. *Journal of Educational Computing Research, 7*(1), 37-50.

Palumbo, D.B. (1990). Programming language/problem-solving research: A review of relevant issues. *Review of Educational Research, 60*(1), 65-89.

Papert, S. (1980). *Mindstorms: Children, computers, and powerful ideas.* Sussex: Harvester Press Ltd.

Papert, S. (1987). Computer criticism vs technocentric thinking. *Educational Researcher, 16*(1), 22-30.

Pea, R.D. (1983). *LOGO programming and problem solving. Technical report No. 12.* N.Y.: Bank Street College of Education, Center for Children and Technology.

Pea, R.D. (1987). Integrating human and computer intelligence. In R.D. Pea & K. Sheingold (Eds.), *Mirrors of minds: Patterns of experience in educational computing* (pp. 128-146). Norwood, N.J.: Ablex Publishing Corporation.

Pea, R.D., & Kurland, D.M. (1984). On the cognitive effects of learning computer programming. *New Ideas Psychology,* 2(2), 137-168.

Pea, R.D., & Kurland, D.M. (1987). On the cognitive effects of learning computer programming. In R.D. Pea & K. Sheingold (Eds.) *Mirrors of minds: Patterns of experience in educational computing* (pp. 147-177). Norwood, N.J.: Ablex Publishing Corporation.

Piaget, J. (1976). *The grasp of consciousness.* Cambridge, Massachusetts: Harvard University Press.

Piaget, J. (1977). *The development of thought: Equilibrium of cognitive structures.* N.Y.: Viking.

Piaget, J. (1977). *The development of thought: Equilibrium of cognitive structures.* N.Y.: Viking.

Reiber, L. (1983). *The effect of Logo on increasing systematic and procedural thinking according to Piaget's theory of intellectual development and on its ability to teach geometric concepts to young children.* (Report No. IR 011 583). Pennsylvania, PA: The Pennsylvania State University. (ERIC Document Reproduction Service No. ED 256 288).

Rowe, H.A.H. (1991). Learning with computers: what type of research? In *Navigating the nineties* (pp. 130-141). Brisbane: Computer Education Group of Queensland.

Ryba, K., & Anderson, B. (1990). *Learning with computers: effective teaching strategies.* Eugene, Oregon: International Society for Technology in Education.

Salomon, G. (1988). AI in reverse: Computer tools that turn cognitive. *Journal of Educational Computing Research, 4*(2), 123-139.

Salomon, G., Perkins, D.N., & Globerson, T. (1991). Partners in cognition: Extending human intelligence with intelligent technologies. *Educational Researcher, 20*(3), 2-9.

Schaefer, L., & Sprigle, J.E. (1988). Gender differences in the use of the LOGO programming language. *Journal of Educational Computing Research, 4*(1), 49-55.

Schibeci, R.A. (1990). LOGO in pre-service and in-service teacher education. *Computer Education, 14*(1), 53-60.

Seidman, R.H. (1989-90). Computer programming and logical reasoning: unintended cognitive effects. *Journal of Educational Technology Systems, 18(*2), 123-141.

Soloway, E., Lockhead, J, & Clement, J. (1982). Does computer programming enhance problem solving ability? Some positive evidence on algebra word problems. In R.J. Seidel, R.E., Anderson, & B. Hunter (Eds.), *Computer literacy: Issues and directions for 1985* (pp. 171-185). N.Y.: Academic Press.

Swan, K. (1991). Programming objects to think with: LOGO and the teaching and learning of problem solving. *Journal of Educational Computing Research, 7*(1), 89-112.

Thomas, J.W. (1986, April). *Aspects of high school programming courses that foster autonomous learning activities.* Paper presented at the annual meeting of the American Educational Research Association, San Francisco.

Thompson, A.D., & Chen Wang, H. (1988). Effects of a LOGO microworld on student ability to transfer a concept. *Journal of Educational Computing Research, 4*(3), 335-347.

Vygotsky, L.S. (1978). *Mind in society: The development of higher psychological processes.* Cambridge, Massachusetts: Harvard University Press.

Walker, D.F. (1987). Logo needs research: A response to Papert's paper. *Educational Researcher, 16*(5), 9-11.

Watt, D. (1982). LOGO in the schools. *Byte, 7*(8), 116-134.

Webb, N.M. (1985). The role of gender in computer programming learning processes. *Journal of Educational Computing Research, 1*(4), 441-458.

Weiner, B. (1979). A theory of motivation for some classroom experiences. *Journal of Educational Psychology, 71*(1), 3-23.

Weiner, B. (Ed.) (1974). *Achievement motivation and attribution theory.* Morristown, N.J.: General Learning Corporation.

Weir, S. (1981). *LOGO as an information prosthetic for the handicapped* (Working Paper No. 9). Cambridge, MA: MIT Division for Studies and Research in Education.

Williamson, P.A., & Silvern, S.B. (1986). Parental teaching style while working with their children on LOGO concepts and the effects of teaching styles on a subsequent task. *Early Childhood Research Quarterly, 1*, 407-415.

Zelman, S. (1985, April). *Individual differences and the computer learning environment: Motivational constraints to learning LOGO.* Paper presented at the annual meeting of the American Educational Research Association, Chicago.

Paper (M4.8c)
Virtual Reality: Magic in the Classroom

Mark L. Merickel
Oregon State University
Corvallis, Oregon

Abstract

This paper is a report on a study of the relationship between virtual reality (i.e., perceived realism) and the ability of children to create, manipulate and utilize mental images for spatially related problem solving. The Creative Technology Project, as it was named, was designed to see if specially designed treatments in Virtual Reality were capable of effecting (i.e., enhancing) various cognitive abilities of children. The abilities under investigation were mental imagery, spatial relations, displacement and transformation, creativity and spatially related problem solving. The project's premise was that these cognitive abilities could be enhanced by having the children develop, displace, transform and interact with 3D computer-generated models and worlds in Virtual Reality.

Experiments were performed using 23 school age children between the ages of 8 and 11 who were enrolled in an elementary summer school program in Novato, California. Two different computer apparatuses were used for the experiments: computer workstations and a Virtual Reality/Cyberspace system developed by Autodesk, Inc. of Sausalito, California. The workstation treatment incorporated three booklets to instruct the subjects on how to solve five different spatial relationship problems. The Virtual Reality/Cyberspace treatment included two scripts to guide the subjects in solving different spatial relationship problems.

Four cognitive ability tests were administered to the subjects. The dependent variable (i.e., spatially related problem solving) was measured with the Differential Aptitude Test. *The three other measures (*Minnesota Paper Form Board Test, Mental Rotation Test, *and the* Torrance Test of Creative Thinking*) were used to determine any effects which Virtual Reality may have had on the subjects' abilities to mentally manipulate two-dimensional figures, displace and transform mental images, and think creatively.*

This study suggests that specially designed Virtual Reality/Cyberspace treatments may enhance children's abilities to visualize and mentally manipulate two-dimensional figures, displacement and transformation of mental images of three-dimensional objects, and assist in solving spatially related problems. The project has shown that the technology known as virtual reality is highly promising as a learning and teaching tool, and should be explored further.

Introduction

When industry, higher education and public schools collaborate on projects involving emerging technologies, everyone can come out a winner. Such was the case when the high-tech firm of Autodesk, Inc., the School of Education at Oregon State University, and the Novato Unified School District in the San Francisco Bay Area collaborated on the Creative Technologies Project designed by this author.

Project Details

The Creative Technology Project was designed to see if designed interaction with virtual reality can enhance various cognitive abilities of children. The abilities under investigation were mental imagery, spatial relations, displacement and transformation, creativity and spatially related problem solving. The project's premise was that these cognitive abilities could be enhanced by having the children develop, displace, transform and interact with 2D and 3D computer-generated models.

Experiments were performed with 23 children between the ages of 8 and 11 who were enrolled in an elementary summer school program in Novato, California. Two different computer apparatuses were used for the experiments: computer workstations and a virtual reality/cyberspace system developed by Autodesk, Inc. of Sausalito, California. The workstation treatment incorporated three booklets to instruct the subjects on how to solve five different spatial relationship problems. The virtual reality/cyberspace treatment included two scripts to guide the subjects in solving two different spatial relationship problems.

Four cognitive ability tests were pre- and post-administered to the children. The dependent variable (i.e., spatially related problem solving) was measured with the *Differential Aptitude Test*. The three other measures (*Minnesota Paper Form Board Test, Mental Rotation Test*, and the *Torrance Test of Creative Thinking*) were used to determine any effects which mental imagery may have had on the subjects' abilities to mentally manipulate two-dimensional figures, displace and transform mental images, and creative thinking.

Training With Computer Workstations

Students in the workstation group were instructed how to use the 386-based microcomputers to develop and manipulate computer-graphic images. The workstations were equipped with VGA-graphics displays and two-button mice.

Students were supplied instruction booklets, developed by this author, that guided them through six different computer-graphic projects.

The first project introduced the students to AutoSketch, a computer-aided drawing program by Autodesk, Inc., by having them draw a "very happy face." The second was a figural-completion task (based in part on the E. Paul Torrance Test of Creative Thinking). Third was a sequential story-building task. The fourth problem included puzzle-building and spatial problem-solving tasks (based in part on the Revised Minnesota Paper Form Board Test by Likert and Quasha). The fifth problem was pattern development and construction (based in part on the Differential Aptitude Test—Space Relations by Bennett, Seashore and Wesman). The sixth was the construction, displacement and transformation of 3D images on a 2D display device (developed by this author).

From the outset, students in the workstation group were enthusiastic and eager to begin. In fact, most were so over-anxious that they did not take the time to follow the instruction booklets. However, with some coaching and patience the children started to follow the instruction booklets and were soon developing their "very happy face" drawings.

After completing their drawings, the students would often look at each others drawings and discuss how they performed various drawing functions. They began to talk to each other in a new technical language:

> "How did you make that arc curve down?"
> "I just picked the third point below the second."

These children were beginning to understand and appreciate the power of developing drawings by using a computer. And as they completed more of their assigned projects, their skills improved. In fact, some of the children got together during their free time and used the graphic and text functions they had learned to develop a prototype school newspaper. Other students began developing very sophisticated graphic puzzles. When the puzzles were completed, they would use editing commands to take them apart. Once apart, they would re-assemble them in various rotations. There appeared to be no shortage of creativity with this group of children.

Training in Virtual Reality

The second group of students were trained in the use of this relatively new technology known as virtual reality or cyberspace. Virtual reality provides a new way of interacting with computers. In virtual reality, users interact with computer graphic models and data as though the models were virtually real. This human-computer interface provides the ability to virtually simulate, and interact with, any "reality" that can be imagined.

Humans experience reality through signals that the senses of vision (light waves), hearing (sound waves), touch (nerve impulses), taste (substances passing over receptor cells, taste buds in the mouth), and odor (nerve impulses in the nostrils) receive. These signals are responsible for the "reality" that our senses perceive and our minds create.

The basic concept of virtual reality is that the computer can generate some of these signals (light and sound waves, and tactile stimuli) to "fool" our senses into "experiencing" a simulated reality. The success of this technology is measured by how well these computer-generated graphics, sound and tactile "illusions" are able to replace our real-world senses.

Under old technology, computer interaction is performed extrinsically, from a point of view of the user standing outside the system and then using input devices to put information into the computer and output devices to get information out of the computer. A virtual reality system is designed to operate intrinsically, with the user being virtually within the computer.

Although the technology of virtual reality is certainly in its evolutionary infancy, it appears to have the potential to "replace" physical reality in a wide variety of applications. In fact, this technology has the potential to go beyond the limits of physical reality by allowing users to explore dimensions such as time and scale. The ability to explore, and interact with, multidimensional virtual environments (including time and scale) will allow researchers, scientists, engineers, teachers, psychologists, architects, artists, and many others to study the behavior of nature and will eventually influence our cognitive understanding of reality…and most certainly the way children learn and teachers teach.

Virtual Reality Component Technologies

There are no unique technologies used in a virtual reality (VR) system. In fact, a virtual reality (VR) system simply brings together a number of existing technologies into a unique assembly. It is this unique assembly of component technologies (and specialized software) which creates a new user interface. The components of a typical virtual reality (VR) system can be broken down into two kinds: those which register behavior and those which provide sensory information. Behavior and sensory components convert data from a virtual world to the users sensory world via a continuous feedback loop (Walser, 1990). The components which make up a typical virtual reality (VR) system include:

Visual Displays

Visual displays used in most VR systems are head-mounted or goggle-like in nature. That is, the displays are positioned directly in front of the user's eyes. The display is either head-mounted using a retaining device to maintain its position in front of the eyes, or a non-head mounted visual display which can be manually positioned in front of the eyes as needed. Virtual environment display devices allow graphic models to be perceived as "real" three-dimensional worlds. This perception is caused by the stimulation of the depth cues of motion parallax and binocular disparity (Merickel, 1991).

VPL Corporation of Redwood City, California has developed a head-mounted three-dimensional display device called EyePhones(tm). EyePhones are head-mounted stereoscopic displays that utilize wide angle lenses which allow a horizontal field of view of 80 degrees for one eye and 100 degrees for both eyes, and a vertical field of view from between 60 to 75 degrees. VPL offers two EyePhones models, the LX and the HRX. The HRX contains two 275 dpi LCD color displays which accept standard NTSC video signals. The LCD matrix of the LX EyePhones is 360 x 240 primary colored pixels, while the HRX offers a 720 x 480 matrix.

Fiber Optic Motion Sensors

Fiber optic motion sensors, ranging from a single glove for monitoring wrist, hand, and finger movements, to complete body suits which are covered with over 500 fiber optic sensors to detect "full" body movements, are used to sense motions and gestures. The most commonly used hand motion and gesture recognition device is the DataGlove produced by VPL Research, Inc. The DataGlove is a computer input glove that converts hand motion into computer readable form. Lightweight fiber optic sensors are mounted on a Lycra(tm) glove, and measure finger flexation. Signals are sent through each of the optic fibers which are located directly above each of the glove fingers and thumb. The fibers are "etched" at each of the finger's and thumb's joints. When the fibers are bent, the signal is attenuated, the more diminished the more the joint is presumed to be bent. The DataGlove can be interfaced through either DATU or a DataGlove Control Unit that contains an integrated positional tracking device.

Position and Orientation Tracking Sensors

Spatial tracking is performed in most of the virtual reality systems by using magnetic field technology. Most commonly, Polhemus 3Space(R) six degree of freedom, magnetic sensors are used for tracking head and hand position (x,y,z) and orientation (roll, pitch, yaw) within a virtual world. Polhemus sensors consist of a transmitter and receiver pair. Via triangulations, these sensors can track a users movements within a 12 foot diameter hemisphere (the center of the hemisphere is located at the stationary receiver pair). Tracking is performed when the user moves head or hand. The transmitter signals the receiver, which in turn signals the computer, which then updates the images on the displays. The signal measured at each of the receivers permits calculations of position within 0.1 inches and orientation [attitude] within 0.5 degrees. Polhemus tracking sensors support interfaces to any host computer system via RS 232 or RS 422 serial communications.

Three-Dimensional Sound

Three-dimensional sound recreates the filtering effects of the irregular shape of the human outer ear (pinnae) to render directional cues (including front-back and up-down cues) for up to four simultaneous sound sources. Current virtual reality systems which employ three-dimensional sound technology use the Convolvotron (tm) from Crystal River Engineering, Inc. The Convolvotron(tm) provides a 320 MIPS real-time signal processing subsystem that recreates the pinnae filtering effects. Exaggerated Doppler shift and other spatial sound effects beyond pinnae filtering are also rendered by the Convolvotron. VPL Research, Inc. uses the Convolvotron to create what it calls the AudioSphere. The AudioSphere contains an integrated digital sound sampler that provides sound sources for use as user interface cues, improved object feedback, and other virtual reality applications.

Graphics Rendering

The graphic images which make up virtual worlds consist of surface rendered three-dimensional models. To perform this function, virtual reality systems must have rendering engines which are capable of rendering the virtual world models with each change of the user's position and orientation. This requires that specific rendering processing be dedicated to each of the two LCD monitors contained within the virtual system display device.

The VPL RB2 system accomplishes this task by using two dedicated Silicon Graphics workstations as rendering engines. The RB2 system can utilize any Silicon Graphics workstation, such as the SkyWriter, as well as other vendors' graphics workstation, in a single or dual configuration for enhanced performance. VPL's RB2 Model 2 system is capable of performing image rendering using a single Silicon Graphics 4D/310VGX workstation configuration.

The Autodesk, Inc. cyberspace (i.e., virtual reality) system, used for this project, requires two graphics boards in a PC-based system (one for each LCD monitor contained in the virtual system display). Currently, the cyberspace system uses two Matrox graphics boards which are built around the Texas Instrument 34010 signal processing chips and custom gate arrays. The Matrox boards are attached to a passive AT backplane which supports a 20Mhz Intel 80386 processor board and a number of serial, Ethernet, and disk controller cards. The matrox boards generate the three-dimensional perspective images which are then converted via NTSC converter into standard video signals. The NTSC signals are then sent to the two LCD displays inside the headset, thus producing a stereoscopic display.

By linking these component technologies (i.e., hardware) together with specially written software, virtual worlds are created and interacted with.

Children Become Cybernauts

The virtual reality experiments of the Creative Technologies Project began with classroom training in the various techniques and physical gestures required for moving within, and interacting with, virtual models. Each child was shown how the DataGlove and the head-mounted display (i.e., VPLs EyePhones) would feel by first trying them on without being connected to the computer.

After the "practice runs," the children were given the opportunity to don the virtual reality apparatus and interact with two different computer-generated, 3D, virtual realities. As the first student placed the DataGlove on her hand and the system was calibrated, you could tell she was quite nervous. After all, this was pretty sophisticated looking equipment. With the DataGlove calibrated, it was time to place the display on her head. As the headset was adjusted on the first cybernaut, her normally boisterous classmates stood absolutely motionless and silent. Then, with the proper hand gesture (making a fist with the palm down), there it was...a virtual world. As big as life, there in front of the youthful cybernaut, was an office-like building. By watching a large monitor, his classmates were able to view the scene as it was displayed in the cybernaut's right headset monitor. You could see the children come to life...excitement truly filled the air.

The children used the cyberspace (i.e., virtual reality) system on two different days to complete the two different experiments. After the first experiment, the children all came out of virtual space extremely excited. In fact, many understood virtual reality for what it actually is. A few commented, "It's like being inside the computer." This is, of course, exactly what virtual reality is all about.

During the second experiment, most students were traveling in virtual space with little or no difficulty. The student's gestures were fluid, and, therefore, so was their traveling in virtual space. The children began to relax and walk around more, even though walking movement is restricted by the cables that attach the DataGlove and head-mounted display to the tracking interface equipment. Students began to turn or walk around in order to track and find various items. The children appeared to have no preconceived notions or reservations about "traveling inside a computer." In summary, these children had become quite proficient with this cutting-edge technology in a very short time.

Project Results

The results of the study indicated that a relationship between perceived realism and the ability of children to create, manipulate and utilize mental images in solving spatially related problems is unverified at this time. The results also indicated that displacement and transformation and visualizing and mentally manipulating two-dimensional objects were significantly related to spatially related problem solving abilities of children (R = .68, F = 8.05, ndf = 1,20, p = .00). Although creative thinking was found not to be significantly related to spatially related problem solving abilities of children, the relationship between spatially related problem solving and creative thinking is still uncertain.

The results also indicated that both groups made significant gains in spatially related problem solving (F = 7.35, ndf = 1,21, p = .013), visualization (F = 5.21, ndf = 1,21, p = .033) and displacement and transformation (F = 23.24, ndf = 1,21, p = .000), however there were no significant gains by either treatment group for creative thinking (F = 1.75, ndf = 1,21, p = .201). Additionally, there was no apparent difference between treatments for visualization (F = 2.40, ndf = 1,21, p = .137) and creative thinking (F = 1.67, ndf = 1,21, p = .211). The workstation group scores were found to be significantly higher than the virtual reality/cyberspace group on displacement and transformation abilities (F = 23.24, ndf = 1,21, p = .000), but there was no interaction between the groups and time (F = .19, ndf = 1,21, p = .671). This would indicate that both groups' scores increased in parallel.

A relationship between perceived realism and the ability of children to create, manipulate and utilize mental images in solving spatially related problems is inconclusive at this time. It still appears important to understand children's spatial abilities in terms of their perceived realism of objects, their encoding of spatial information into mental images, and their subsequent use of those images in solving problems.

Finally, spatially related problem solving abilities of children are influenced by training in visualization and mental manipulation of two-dimensional figures and displacement and transformation of mental images of three-dimensional objects. Additionally, the treatments used in this study enhanced children's abilities to visualize and mentally manipulate two-dimensional figures, displace and transform mental images of three-dimensional objects, and solve spatially related problems. Further research regarding computer workstation graphic-based treatments and perceived realism and their relationship to problem solving should be undertaken. Virtual reality/cyberspace and the workstation treatments used in this study enhanced children's abilities to visualize and mentally manipulate two-dimensional figures, displacement and transformation of mental images of three-dimensional objects, and solving spatially related problems.

Implications of the Project

Today, computers, software and even approaches to instruction may be adopted purely on a speculation of outcome. That speculated outcome, however, may not occur. The Creative Technologies Project was an attempt to test the outcomes of using new technologies before naive and inappropriate educational methodologies are adopted for classroom use. The project was specifically designed to provide answers to the question: can the development, displacement and transformation of, and interaction with, 2D and/or 3D computer graphics enhance a child's ability to create, manipulate and utilize mental images; their spatial and visual abilities; displacement and transformation abilities; creative thinking ability, and spatially related problem-solving abilities?"

This project showed that additional research on particular interactions between 2D and 3D computer graphics and virtual reality, and various cognitive abilities of children, is warranted. The research has also shown that the technology known as virtual reality is highly promising and deserves extensive development as an instructional and training tool. But equally important, the cooperative efforts required by Autodesk, Inc., the School of Education at Oregon State University and the Novato Unified School District proved beneficial to all involved. Industry was provided feedback on their technology in action. Education is allowed to test innovative approaches to instruction in a controlled setting and use state-of-the-art equipment. And the children get to fly!

References

Bricken, W. (1990). *Virtual Reality: Directions of Growth.* Notes from the SIGGRAPH 1990 Panel.

Brooks, F.P. (1988). *Grasping reality through illusion-interactive graphics serving science.* ACM SIGCHI.

Fischer, S.S., McGreevy, M., Humphries, J. and Robinett, W. (1986). *Virtual environment display system.* ACM Workshop on Interactive 3D Graphics, University of North Carolina, Chapel Hill, North Carolina.

Gibson, W. (1984). *Neuromancer.* Ace Books. New York, NY.

Johnson, M. (1987). *The Body in the Mind: The Bodily Basis of Meaning, Imagination, and Reason.* The University of Chicago Press. Chicago, IL.

Kruegar, M. (1982). *Artificial Reality.* Addison-Wesley.

Merickel, M. (December, 1990). The Creative Technologies Project: Will Training in 2D/3D Graphics Enhance Kid's Coginitive Skills? *T.H.E Technological Horizons in Education Journal. (18)* 5, pp. 55-58.

Merickel, M. (1991). *A Study of the Relationship Between Percieved Realism and the Ability of Children to Create, Manipulate and Utilize Mental Images in Solving Problems.* Doctoral Dissertation. University Microfilms Inc.(DAO 64793). Ann Arbor, MI.

McGrath, M. & Merickel, M. (1992). *Research Project Findings: Exploration and Evaluation of Virtual Reality Technology.* Internal Paper, Waterways Experiment Station—U.S. Army Corps of Engineers. Vicksberg, MI.

McLuhan, M. (1964). *Understanding Media: The Extensions of Man.* Signet Books. New York, NY.

Nelson, T. (1974). *Computer Lib / Dream Machines.* Published by the Author.

Papert, S. (1980). *Mindstorms: Children, Computers, and powerful ideas.* New York: Basic Books, Inc.

Sutherland, I. (1968). *A head-mounted three dimensional display.* FJCC, Vol. (33), pp 757-764.

Walker, J. (1988). *Through the Looking Glass.* Internal Paper, Autodesk, Inc. Sausalito, CA.

Walser, R. (1990a). *The Emerging Technology of Cyberspace.* Autodesk, Inc.: Sausalito, CA.

Walser, R. (1990b). Elements of cyberspace playhouse. *Proceedings of the National Computer Graphics Association, Anaheim, March 19-22.*

Projects (M4.9)
Telecommunications

Montana Telecommunications Project (METNet): Distance Education in Big Sky Country

Janis H. Bruwelheide
Montana State University
Bozeman, MT

Abstract

The Montana Legislature (HB30) established the Montana Educational Telecommunications Network (METNet) "to support education, economic development and government services in the state." The Office of Public Instruction, the Office of the Commissioner of Higher Education, and the Department of Administration are working cooperatively to develop METNet.

METNet provides:

- instructional and education course work for K-12 students, students enrolled in units of the Montana University System, and vocational-technical centers and community colleges
- instructional and professional development training for teachers and others involved in education
- telecommunication capabilities to schools, state agencies, subdivisions of state government, and public libraries

METNet has three components: bulletin board system, compressed video, and satellite.

Kid Link: Telecommunications in a Global Community

Carylie Lawson
St. Charles Parish Schools
Luling, LA

Abstract

As we embark into the twenty-first century, educators must realize the importance of incorporating computer technology into the core curriculum. Educators in St. Charles Parish, Louisiana have done this through a global telecommunications project entitled **Kid Link: Learning On Line**. Telecommunications is integrated into the areas of Language Arts, Science, and Social Studies.

This presentation will inform participants how to effectively and successfully establish telepartnerships with classrooms around the nation as well as the globe. Steps for setting up national and international partnerships will be outlined with emphasis on the following goals:

- Incorporate technology into the curriculum
- Access information on current events and topics for research
- Exchange, conduct, and compare results of science experiments
- Learn of the diversity among peoples by sharing cultural information
- Become active partners in the world community by thinking globally while acting locally

Students in elementary classrooms were exposed to new avenues of learning through the process of telecommunications. Working with cooperative group settings within their respective classrooms, they conducted research, wrote reports, collected scientific data, and shared diverse social and cultural information. Technology was used by teachers to enhance activities that enabled students to become active, collaborative learners while using hands-on activities investigating, inquiring, and discovering new knowledge. Students became self-confident, independent learners and developed critical thinking skills necessary to become skilled, productive workers in the twenty-first century.

Kid Link is a project that has been formed among elementary schools within the United States, and most recently ex-

panded on a worldwide level, using one elementary classroom as a pilot to test the practicality of transatlantic communications. Specifically, a Russian partnership was formed for this means, and the steps involved in establishing this partnership will be reviewed. Successes and cautions will be shared.

Kid Link is a non-commercial venture currently supported by St. Charles Parish Schools and extended on a worldwide basis free of charge to participants.

This abstract was taken from the author's originally submitted proposal

Choosing On-Line Solutions for Your School: Which One is Right?

Rachel Pinson
Mountain Brook High School
Birmingham, AL

Abstract

It is no secret that telecommunications and "on-line" service are an essential element of our schools and educational system. School libraries, offices, and, increasingly, classrooms are being equipped with computers and modems so that students and teachers can accomplish objectives like: "providing appropriate opportunities for students to become technologically literate; providing opportunities for students to use technology to enhance their learning in all curricular areas; and providing opportunities for students to experience their world-wide citizenship."

Just as it is vital to have definite educational goals and objectives, it is also important to pay close attention to choosing the right tools to accomplish those goals and objectives. This presentation will look at the types of telecommunications that are available and share a process for evaluating and choosing the correct service for a given school situation.

Specifically, the program will present an overview of telecommunications and share ideas about ways that it can be utilized in school settings. Secondly, the program will present a four-step process for evaluating and choosing an on-line service. Thirdly, the program will look at some technical and logistical considerations to be made. Finally, the program will address the issues of evaluating, analyzing, and updating the use of telecommunications services within a school.

Without a doubt, telecommunications can be one of the educator's most powerful tools and motivators. Just as with other tools, however, if it is not the right one, it is virtually worthless. This presentation will help educators avoid making a mistake and it will give them the knowledge to choose a valuable tool that is right for them!

Motivation for Conversation: International Relay Chat (IRC)

Jude Sacry
Colorado Foreign Language Teacher of the Year
Boulder Valley Schools
Lafayette, CO

Abstract

As a foreign language teacher and a participant in the Boulder Valley Internet Project, one of my missions is to integrate the use of the Internet resources into the curriculum. The International Relay Chat (IRC) is a terrific resource within the Internet for students of a foreign language.

Students may request access to the Internet. Both the student and a parent are required to sign a contract which specifies user responsibility and "netiquette." Due to the controversial nature of some discussions on IRC, the parent is also required to sign an additional permission form following a demonstration of the chat feature.

IRC access has been outside of class with the exception of some student training. In-class use is preferred; however, with only a modem connection this is not practical.

IRC allows students to participate in real-time Spanish discussions with people all over the world. This has positive effects: a greater willingness to learn additional grammar, vocabulary, and culture, and an increase in comprehension and speaking abilities. Students are also more aware of spelling. They no longer wonder if they will ever use the foreign language, but can apply their knowledge immediately, which provides motivation and excitement.

Projects (M4.10)
Special Populations & Instructional Applications

Developing an Ecology Unit for Native Americans

Barbara Brehm
Eastern Montana College
Billings, MT

Abstract

This session will present an overview of an ecology thematic unit and discuss the success and problems of working in a new middle school environment with a large Native American population. Activities included a variety of software as well as a telecommunications project. Community members served as resource people on ecological concerns and told legends of the Crow Tribe. Students volunteered for a community clean-up project and published a newspaper on ecological issues including ones of the local community. Handouts will include an overview of the thematic unit and sample activities which could be adapted for younger students.

Summer Magic at Computer Camp

Adrianne Hunt and Judy Anderson
Calcasieu Parish Schools
Lake Charles, LA

Abstract

The Calcasieu Parish School System, located in the southwest corner of Louisiana, has established a Technology Training Center where teachers come to learn to use new technology tools. The Tech Center staff, recognizing the need for continued learning in the summer for adults and children, sponsors an annual Computer Camp. The camp provides fun and enrichment for all involved and also puts the technology equipment to good use, year round.

Nearly 300 youngsters in grades 3-8 attend. Staffed by master technology teachers, the camp provides each child extended hands-on time in six curriculum areas: desktop publishing, art, video production, science and technology, exploratory lab, and multimedia. Software in use includes Linkway, HyperStudio, Toolbook, HyperCard, the Writing Center, Prodigy, a wide variety of laserdiscs and CD-ROMs—in short, the best in children's computing.

Many rewards are tangibly linked to the camp— parents are delighted and amazed to see their children sit down confidently to many different kinds of equipment; teachers get a summer salary boost; the project provides an ideal inservice setting; and local news media provide good news about education to the community. A summer computer camp is truly a magical experience for all.

Technology Meets Bilingual Education in a Large Southwestern Pueblo

Patricia Jury and Elizabeth Whitaker
Tucson Unified School District
Tucson, AZ

Abstract

The Tucson Unified School District over the past two years has been involved in installing Learning Labs in each of its 73 elementary schools. One of the district's quests has been to design a lab which supports instruction in all areas of the curriculum, including a Maintenance Bilingual Education program. The software initially installed addresses the Language Arts curriculum and provides tool-based software in both English and Spanish which promote writing skills, higher level thinking, and creativity.

This presentation will include an overview of the philosophical base supporting these labs which supports bilingual instruction. Specific issues include educating vendors for the development of educational software for bilingual instruction, and district policies which aided in these efforts. Examples of students' products and teaching ideas developed with this technology will be available. This presentation is currently not a commercial product nor a venture.

Bringing Technology To All Disciplines

Larry McHaney, Margaret Reed, Janice Kelso, Madeline Howard, Greg Gaston, Aubrey Hillman
TEC•Lab
The Woodlands, TX

Abstract

Participants will learn about an innovative and exciting multi-cultural project involving science, math, language arts, social studies, and technology classes at McCullough High School: The Technology Educational Curriculum Laboratory (TEC•Lab). Funded by a Texas Education Agency Innovative Programs Grant, the TEC•Lab is studying the effects of a technology rich environment on students' learning, attitudes, and achievement.

Equipped with a vast array of the latest technologies from computers and FAX machines to video editing equipment and Computer Numeric Control machine tools, the TEC•Lab offers a unique opportunity for bringing the world into the classroom via modem, FAX, cable TV, and teleconference calls. With the help of our community advisory committee, we also get students out into the world. We involve students in real projects for companies, individuals, and organizations that incorporate the curriculum and require the use of technology.

All of the teachers representing their disciplines will share what they have learned from this experience: teaching strategies, innovative activities, the most successful software and hardware, and preliminary results of the research study.

The TEC•Lab is a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Projects (M4.11)
Restructuring & Instructional Applications

Lee County's Pilot Technology Schools: The Foundation for Long-Term Planning

David Kreller, Tim Osborne, and Mike Jones
Lee County Schools
Fort Myers, FL

Cyndy Loomis
Information Systems of Florida
Jacksonville, FL

Abstract

In August 1991, the School District of Lee County selected seven schools to participate as pilot technology schools. The purpose of the pilot schools was to enable the district to experiment with various instructional and managerial concepts and to lay the foundation for implementing technology throughout the district.

Each school was targeted as either an Apple or an MS-DOS school, with the district allocating between $360,000 and $600,000 for training, hardware, and software. The schools were also required to use different approaches for integrating technology so that multiple methods could be evaluated. During the 1991-1992 school year, the pilot schools installed school-based networks to support instruction, management functions, and electronic mail.

After the pilot school project was initiated, the district started its development of a five-year technology plan encompassing both instructional and administrative areas. The highly participatory planning process involved over 90 district administrators and teachers as well as community representatives. The resulting comprehensive technology plan was the result of a yearlong effort and is in the process of being implemented by the district.

In the fall of 1992, the district evaluated the efforts of the seven pilot technology schools. The purpose of the evaluation project was to capitalize on the experiences of staff involved in the pilot schools and to disseminate this information to other schools in the district. The district has also initiated a long-term evaluation to summarize and measure the impact of technology on student learning and the students' ability to use available technologies.

This project presentation will give an overview of how pilot technology schools can serve as the starting point for districtwide technology implementation. Handouts will include a profile of each pilot school and a description of the participatory planning process used to develop the district's five-year technology plan. This project is currently a noncommercial product or venture.

The Magic Continues

Bronwyn Rhoades, David Smith, and Larry Martin
Mendocino Unified School District
Mendocino, CA

Abstract

Windows to the Future is a restructured program embedded into a traditional high school program. The program is a series of integrated courses in multiple technologies, language arts, and social science. The success of this California State funded program depends on the collaboration of teachers, vocational staff, students, administrators, parents, and community members. Based on sound educational research and the SCANS report , teams of teachers assist students in developing multimedia projects which explore stringent curriculum concepts.

Merging the academic high school courses with the vocational training options offered by the county's Regional Occupational Program in video, audio, and multimedia computers, we have designed an educational program which focuses on problem solving, higher order thinking skills, collaboration, self assessment, and time management. Students exit the program with occupational certificates, multimedia "power portfolios" and real life job skills. Internships and apprentice-

ships allow students to extend learning beyond the classroom and into the community.

This program has altered instructional practice, student assessment, the roles of students and teachers, and the connections between school and community. Technology as a teaching and learning tool has been the catalyst for restructuring. By taking already strong programs and linking them together, we've created something entirely new. Year one was trial by fire. We will share with you the results after year two.

Local School Technology Leadership: The Key to Success

Bard Williams and George Bagwell
Gwinnett County Public Schools
Lawrenceville, GA

Abstract

Leadership is a key element in the success of instructional technology. Schools around the nation are struggling to find the best way to optimize curriculum and technology expertise. Should every school have an on-site technology leader?

This project will present an infrastructure developed for Gwinnett County Public Schools, Georgia, designed to establish and enrich a network of local school technology leaders. Participants will explore a sample job description as well as methods for the establishment of open lines of communication between and among school sites and the district office. Included will be a discussion of the role of telecommunications and technology planning in establishing a successful local school technology program.

Technology Peer Assistants: Empowering Students

Mary S. Haverfield and Sherah Carr
Gwinnett County Public Schools
Snellville, GA

Abstract

Imagine the excitement of having students actively involved in the process of teaching technology. This presentation will highlight the features of training, organizing, and empowering student technology assistants in your school. Examples from two middle schools will illustrate how students in this program increase self image, obtain higher level thinking, effectively communicate, and achieve self direction. Through a training program called Technology Peer Assistants, students have the opportunity to learn and teach the complexities of a myriad of computer skills in both computer lab and classroom settings. Participants will be given a general outline of the student training curriculum and helpful hints on managing student assistants. Multimedia training clips created by the student assistants will be presented.

This presentation presents ideas and materials created by the presenter and represents a non-commercial product or venture.

Projects (M4.12)
Educational Software

Bilingual Software/CDs Ensure Equal Opportunities in Elementary Classrooms

Chencho Flores
Angela Mielke
Elgin Primary School
Elgin, TX

Abstract

The learning context of our schools must adapt to our changing world, from one in which students are receptacles to be filled by the teacher, to a student-centered learning environment. Technology is a significant source to aid schools in achieving instructional strategies which are meaningful, active, and sensory, connected to the real world, in which students are able to construct meaning from their learning and apply it to their lives.

We will demonstrate the latest in Bilingual (Spanish/English) technology using the Macintosh computer and CD-ROM. A demonstration of bilingual software will be given. Software programs to be shown will include the Story Tailor series (Humanities Software), and Discis Books and Brøderbund talking books. The Story Tailor series contains story templates in Spanish and English. Stories are customized to make students the main characters. Students' own ideas are also incorporated into the story. The "talking" books are children's stories which use a CD-ROM player with a computer. Animation, sound effects, talking characters, and music are all elements of these stories. Spanish translations of words are included. Participants will receive a list of bilingual software available.

Technology Building Blocks For Literacy

Laurie Rosenthal and John Black
Department of Communication, Computing, and Technology in Education
Teachers College, Columbia University
New York, NY

Abstract

While literacy is important to the success of the individual in our society, for some, literacy skills are not well developed. Parents who are not confident about their own literacy skills are unable to serve as good models for teaching their children the importance of these skills. Children coming from families where literacy skills are poor begin school at a disadvantage, thus continuing the cycle.

The solution we propose is to have adults, whose literacy skills need strengthening, work with preschoolers at the computer in an intergenerational setting. Our rationale is that through helping their children to develop their literacy skills, participating adults will be motivated to practice their own literacy skills, as well as further develop their ability to work in groups, thus increasing their own sense of empowerment while also providing the children with necessary positive role models for the importance of these skills. Building Blocks, a HyperCard based software program, was specifically created to capitalize on the unique learning situations present in the intergenerational literacy settings. Adults using the program have at least a fourth grade reading level, and the children are non-readers, although the program can be used by children who are beginning readers, or by those learning English as a Second Language. Users work together in intergenerational dyads.

Building Blocks has already been pilot tested. The program held users' interests, was easy to use, and promoted discussions between users. Several children later expressed a desire to apply information from the story to a real-life project. From observations and users' suggestions, we have already made several modifications to the program. Future plans include the addition of sound and the creation of a colorized version. The results of testing and full implementation will later be outlined in a formal paper.

The features of this program will be demonstrated through computer presentation, discussion, and handouts.

This project is currently a non-commercial product/venture.

This abstract was taken from the author's originally submitted proposal

Using Technology to Enhance the Teaching of Writing at the Secondary School

Harriet Scarborough
Chapter 2 Instructional Technology Training
Tucson, AZ

Allen Swanson
Tucson Unified School District
Tucson, AZ

Abstract

Research on written composition has shown that writing improvement increases the more students engage in the writing process. It is hypothesized that providing students with access to computers should contribute to writing improvement since computer use should facilitate revision, a key stage in the writing process. The presenters will outline the result of a study comparing two English classes, one that uses the computer lab on a regular basis and one that does not. The focus of the discussion will be the differences exhibited by these two classes in the area of writing improvement, and also in the peripheral areas of attitude towards writing, length of pieces, and the frequency of writing.

Technology-Assisted Language Learning (Project TALL) for ESOL Students in Grades K-12

Joanne Urrutia
Dade County Public Schools
Miami, FL

Michael Eason
Florida Department of Education
Tallahassee, FL

Abstract

This is a three way co-development project in which the Florida Department of Education has invested $3 million, Dade County Public Schools has provided the curriculum and design expertise, and Jostens Learning Corporation has matched the Florida DOE's investment to create instructional materials for Limited English Proficient (LEP) students in grades K-12. The purpose of the project is to create an instructional program that makes use of the latest technologies such a high quality graphic animations, digitized speech, CD-ROM, and instructional management systems. The design promotes both English language acquisition and higher order thinking skills.

The project empowers LEP students to fully participate in their own learning, with state-of-the-art computerized tools designed to promote application of newly acquired English language skills in stimulating discovery activities. The design uses natural language approach to second language development and integrates the use of technology in the classroom. This comprehensive package includes thematic units in which students encounter stories, songs, poems, and conversations that broaden their vocabulary base and introduce the concepts they need, to acquire essential English language skills. At the secondary advanced level, unit themes are related to academic content areas. Other tools included are: writing processors, databases, spreadsheets, and desktop publishing programs, picture dictionaries, and an electronic encyclopedia.

Projects (M4.13)
Teacher Training

Hypermedia Use in a Constructivist Approach to Introductory Earth Science

Patricia A. McClurg, James McClurg, J.R. Boyd, and Andy Bryson
University of Wyoming
Laramie, WY

Abstract

Two hypermedia activities were developed, piloted, revised, and tested in conjunction with a four-year NSF Grant. The two modules, appropriate for secondary and University introductory earth science courses, are based on active learning theory. Dribble files were used to refine the modules and to document students' strategies. Small cooperative groups of two to three students were found to benefit the most from the treatment.

Whiplash—[Plate Tectonics]. Pattern detection is the unifying theme targeted in this interactive multimedia exercise. Users access information regarding plate tectonics and the movement of plates via animated computer graphics and animated sequences from a videodisc to compare early concepts of continental drift with current theory. Students then are challenged to arrange the continents as they predict their appearance 50 million years in the future and calculate velocity of plate movement.

Modeling the Planet's Interior. The goal is to help students understand the dynamic nature of science as well as realize that a model can satisfy known parameters, but needs to be modified in the face of new evidence. This interactive exercise challenges students to develop a model for the interior of the earth which satisfies the displayed parameters of angular momentum and mass.

Distance Education: The Application of Technology to Education and Training

Al P. Mizell and Lois Ann Hesser
Nova University
Ft. Lauderdale, FL

Abstract

Field-based graduate programs at Nova University are delivered in two basic formats: the cluster approach; i.e. a professor flies in to meet with a group of students for a weekend of instruction, and the electronic on-line delivery system where a student uses a personal computer and modem for the delivery of instruction directly into the student's home. Recently, the need to provide greater depth in the use of technology to improve the instructional process was recognized, resulting in the development of a new doctoral specialization known as the "Application of Technology to Education and Training" (APTEC).

The specialization component is a major feature of Nova University's Child and Youth Studies doctoral program. APTEC provides technically proficient professionals with instruction designed to extend their computer skills and to enhance their positions as educational technologists. The program, appropriate for persons who hold, or wish to hold, such varied positions as technology coordinators, computer educators, information or media specialists, learning resource personnel, classroom teachers, or administrators, incorporates the use of the emerging technologies as essential tools in the fields of education, training and program management. Action-oriented projects (2), are completed in the area of specialization. Details of and examples from the APTEC specialization are shared in this presentation.

Computer Technology For Elementary and Middle School Students at USC-Aiken

Gary J. Senn
University of South Carolina at Aiken
Aiken, SC

Abstract

Integrating instructional technology into school curricula is a great concern. A major problem is providing funds to purchase the necessary hardware and software to make the technology available to teachers. Another major problem occurs when the funds are finally available and the process of integration begins. Too often, the teachers are not provided adequate training to integrate the instructional technology into their classes. The result is that instructional technology is available but is not integrated.

The Computer Technology For Elementary And Middle Schools (CT FEAMS) program provides students and teachers with hands-on experiences in science and mathematics using computer technologies. The purpose is to demonstrate to teachers how instructional technology can be integrated into their curriculum through two programs.

The first program consists of a graduate course for the teachers. The teachers receive training on computer assisted instruction programs, word processors, data bases, spreadsheets, laser videodiscs, and hypermedia. The experiences from the course demonstrate how teachers can incorporate instructional technology and provide them with the necessary information to make educationally sound decisions when they have the opportunity to purchase technology oriented materials for their classrooms.

The second program involves the students. The teachers accompany their students to the Ruth Patrick Science Education Center (RPSEC) at USC-Aiken. Each group of students comes to the RPSEC once per month for six months. While at the RPSEC, the students receive hands-on experience with instructional technology. All of the activities in which the students are involved are covered during the graduate course that the teachers take prior to the student program. Therefore, the teachers are already familiar with the activities their students are doing and can provide the students with guidance and direction. The teachers relate the activities at the RPSEC to the learning activities at their school. Since the teachers are actively involved in this program they gain hands-on experience in integrating instructional technology.

Building a Virtual Community of Teacher Researchers

Patricia Tinto
Syracuse University
Syracuse, NY

Barbara Shelly
Westhill High School
Syracuse, NY

Nancy Zarach
Syracuse City School District
Syracuse, NY

Abstract

This presentation will describe the development of an on-line community of faculty from schools and universities who are addressing issues connected with reform in the mathematics classroom.

The project looks at technology as a tool for communication and as a tool for professional development. It makes use of the expanding role of e-mail, to support on-line collaborations of teachers, mathematics educators, mathematicians, curriculum developers, and others involved in teacher initiated research. This "model community" focuses on issues surrounding teacher conducted research projects on the role of cooperative group learning strategies, technology, and the role of conjecturing within the mathematics classroom. On-line communication facilitates sharing of information and accessing findings from the communities' research efforts.

This project acts as a model for developing communication using emerging national networks. It addresses such questions as: How is a virtual community sustained? What type of product facilitates interaction? What roles must community members take on?

This project is a non-commercial venture; it is part of an NSF SGER funded project for 1992-93.

Projects (M4.14)
Teacher Training

Technology Integrated With Models of Teaching

Phyllis Hotchkiss and Michael Land
Midwestern State University
Wichita Falls, TX

Abstract

In an effort to make instruction engaging, visual, and appealing to students, the presenters have developed concept attainment, inductive, and mnemonics lessons to illustrate how instruction may be enriched when technology is included in lesson design. The lessons presented are based on the Models of Teaching text prepared by Bruce Joyce and Marcha Weil. Hyper-card, digitized video, and CD ROM are among the technologies incorporated in these lessons.

The Roving Workstation Project: A Model for Improving Teacher Education Faculty Use of Technology

Julie A. Poage and Dorie Munson
Gonzaga University
Spokane, WA

Abstract

The infusion of technology into education has created an immense dilemma in the arena of teacher education. That is, how to best involve and encourage teacher education faculty to model the integration and use of technology to preservice teachers. In an attempt to promote the integration of technology throughout the teacher preparation program, the following systematic model has been proposed. This model is designed to facilitate the use of technology by teacher education faculty by: 1) providing easy access to state-of-the-art technology; 2) encouraging participation in the project and reinforcing the value and importance of the project by providing a stipend to participating faculty; and, 3) providing individual instruction and technical support to the participating faculty during the development of instructional materials.

The project will be completed in five phases, 1) Project Identification and Faculty Selection; 2) Training; 3) Development; 4) Classroom Integration; 5) Revisions and Dissemination. A technology leader will be identified to help select projects, provide technical support and training during development, and help with the integration and assessment of the instructional materials. An analysis of both quantitative and qualitative data collected during the project will be provided as a means for future support and student impact.

Technology in Florida's Teacher Education Programs: Investigating the Issues

M. D. Roblyer
Florida A&M University
Tallahassee, FL

Ann Barron
University of South Florida
Tampa, FL

Abstract

While it is generally acknowledged that "technological literacy" is becoming an increasingly important part of teacher competency, there has been little evidence in the literature that teacher education programs address this need in any systematic way. This study was conducted to investigate how technology is being integrated into teacher education programs in Florida. A sample of faculty members at each of the state's nine public universities was interviewed through a questionnaire that focused on three aspects of technology integration: (1) the degree to which technology-based skills are being addressed in the form of fundamental technology concepts and within six content areas; (2) access that students and faculty have to technology resources; and (3) obstacles that faculty feel are

impacting their use of technology in teacher education courses. Descriptive data are reported on findings in each of these areas, and recommendations are made on how these issues should be addressed to help assure that future teachers are technologically literate.

Discovering the Magic of Multimedia

Maria Swayne, Maria Tavares, and Karen Hare
Los Angeles Unified School District
Los Angeles, CA

Abstract

Interactive video instruction is an exciting way to present whole-language lessons in an multi-media environment. Instructors will find it relatively easy to integrate this technology in the classroom as they adapt it to fit their educational programs. With the use of HyperCard™, teachers and students can create unique learning programs that allow the user to control and interact with the laserdisc player.

If HyperCard™ is a mystery to you, then come investigate many exciting ways to use HyperCard™ and Interactive Video (and QuickTime) in grades K-5 across the curriculum. Teacher and student created HyperCard™ stacks are lined up.

Since the majority of our students are identified as Limited English Proficient, there is a serious need to give them the maximum number of opportunities for visual and audio learning which would spark and increase their reading, writing and oral language skills. Videodisc technology learning is not only an excellent method to enhance ESL/Science/Social Studies instruction, but it also empowers students to become confident, highly motivated, successful learners.

Most of the stacks will focus on the students' uses of critical thinking and problem solving skills, rather than rote drill exercises. The HyperCard™ Stack *Frog and Toad*, for instance, prompts the users to write a letter and tell about their feelings. Another stack, *De Mi* focuses on self-awareness and asks the students to choose frames (images) from the laserdisc and then write about their selections. In addition, the children are able to enhance their stack by drawing pictures with the art tools, adding cut and paste clip art, scanning in family pictures through the flatbed scanner, or using MacVision to insert their own images to go with their writing.

Many of the other HyperCard™ stacks incorporate the ideas of literature-based, whole-language instruction. The end results are that the children create an instructional tool that is fun and motivating. Three dimensional learning occurs.

Posters (M4.15)
Research

Distinctiveness of Icons in the Graphical User Interface
Larry Johnson
University of Southern Indiana
Evansville, IN

Information Needs in Medium Size School Districts
Noreen Michaud
Simbory School District
West Hartford, CT

Integrating Different Formats of Research Results on Distance Education in Pakistan
Hiroo Saga
National Institute of Multimedia Education
Yokohama, Japan

Cognitive and Motivational Change of an Autistic Child through Using the Computer
Chiyoko Terayama
National Institute of Special Education
Yokohama, Japan

Tuesday

Spotlight Sessions (T1.1)

Here Come the Robots: An Educational Robotics Update
Tom Lough, Panel Chair
LEGO Dacta
Enfield, CT

Abstract

This panel will focus on current classroom activity in educational robotics from a variety of perspectives, and will seek to provide indications of likely future developments. Teachers with educational robotics experience from the elementary, middle, and high school levels as well as a representative of the university community will share information about their past and current educational projects, and reveal plans for future projects. There will be ample opportunity for questions from the audience.

Panelists:

Julie Thomas
University of Nebraska
Lincoln, NE

John DeBose
Indiantown Middle School
Indiantown, FL

Walter Deal, III
Old Dominion University
Norfolk, VA

Spotlight Sessions (T1.2)

The Disney Partnership: Parents, Kids, and Teachers
Brian Napak

Abstract

Abstract not available at press time

Spotlight Sessions (T1.3)

Florida Schoolyear 2000: Restructuring Schools on a Technology Base

Owen Gaede
Florida State University
Tallahassee, FL

Abstract

Florida Schoolyear 2000 is a multiyear joint initiative between the Florida Department of Education and the Center for Educational Technology at Florida State University to design and implement a new model of schooling based on the effective use of technology. The new model of schooling is being designed concurrently by statewide design teams using a systems approach. Seven school districts, including 27 schools, have been designated as collaborating school districts and are directly involved in the development and field testing of the model.

Central to the Schoolyear 2000 model are electronic systems designed to provide the support for all other systems comprising the model. The electronic systems will consist of three primary components: network communications, an intelligent knowledge database, and a learning support system. Pen computers using wireless networks will provide electronic performance support systems (EPSS) for faculty at all levels.

The proposed workshop will feature an overview of the Schoolyear 2000 initiative, an in-depth review of the planned electronic systems, and a panel discussion by members of the State Design Team for Electronic Systems.

Panel members include:

Wendy Cullar
Peggy Kinder
Marty Beech
Pam Zimpfer

Spotlight Sessions (T1.4)

The School Administrator as a Technological Leader

Chase Crawford
Florida Department of Education
Tallahassee, FL

Martha Rahming
Garden City Elementary School
Ft. Pierce, FL

Henry Pollock
Rivera Middle School
Miami, FL

Abstract

This session will cover the topic of teaching technology to public school administrators. Topics of discussion included in this subject area will be:

- Technology competencies and skills required of Florida school administrators for Level 1 certification
- Identification of different student backgrounds and needs
- Different delivery models used to teach competencies and skills, especially for applications software, new technologies, state data base requirements, FIRN usage, and others
- Considerations for changes in technology competencies and skills with audience participation

This abstract was taken from the author's originally submitted proposal

Spotlight Sessions (T1.5)

Musical Applications of Educational Computers

Fred Hofstetter

Abstract

Abstract not available at press time

Society Sessions (T1.6)

Teaching and Learning with Technology in the Classroom

Special Interest Group on University and College Computer Services (ACM / SIGUCCS)
James Kerlin
The Pennsylvania State University
University Park, PA

Abstract

The use of technology in the classroom provides the opportunity for instruction to increase learning by adding to the types of instruction, by bringing new and previously inaccessible materials into the classroom, by providing more information in a shorter period of time, by saving valuable presentation time, by involving the learner in the learning process, by allowing for alternatives to be presented, and by connecting the classroom to the world outside the classroom. To be successful in the use of technology in the classroom requires three components. They are classroom technology, technology in the instructor's office, and instructor training. This paper considers the needs for the design of technology classrooms, the continuing support for such classrooms, and the support for the instructor using the classroom.

Paper (Tl.7a)
A Computer Based Presentation of an Introductory Programming Course

John A. Cicero and John Groppe
Illinois Benedictine College
Lisle, Illinois

Abstract

The purpose of our Howard Hughes Medical Institute grant was to develop a computer based presentation of our introductory programming course. This introductory course teaches students problem solving techniques using the Pascal programming language. All of the class notes, examples, and homework assignments are contained on disk. These notes are presented in class using a hypermedia presentation package. Then, the students are able to replay all of the class notes at their convenience. This project has been most successful for several reasons: students spend more time in class understanding the material presented rather than taking notes; difficult concepts are illustrated with computer simulations; and classroom presentations can be replayed for greater understanding.*

Introduction

Illinois Benedictine College received a Hughes grant to develop a computer based presentation of our introductory programming course. This paper describes the course, the equipment selection, the project description, and the project results.

The students enrolled in this one semester introductory programming course are either beginning the computer science major, or satisfying the requirements of another major. Some students have previous programming experience, while others have none. The students with previous programming experience range from *computer hackers* to formally trained programmers. As a result, student interest, ability and attention levels vary greatly. Therefore, it was our intention to create a course that was informative, interesting and (optionally) self-paced. (i.e., we felt it was essential to create a mechanism so that students could replay all the classroom lecture notes at their convenience). In addition, we added some interesting software presentations (developed by our upper classmen) to encourage students to consider computer science as a major.

Equipment

The equipment required for this course is minimal. It includes:

1. IBM LinkWay(TM), Version 2.01. This package is at the heart of the project. It supports hypertext, hypermedia and multimedia presentations. We chose this package for several reasons: it is inexpensive (under $100), it contains a run time version that permits unlimited distribution of a student copy, and it is easy to use.
2. Borlands Turbo Pascal 6.0 (TM). This package is used to develop all of the simulations presented in the project. The simulations were linked into the entire package through LinkWay. Significant programming knowledge is required to make effective use of this package, however, optional animation software could be purchased to accomplish most of the simulations without extensive programming skills.
3. A personal computer with color capability.
4. An overhead projector.
5. A Universal LCD Display Device. This device is used to project the images that appear on a computer screen onto the overhead projector. That image is then projected onto a large screen so that the entire class can view the presentation. A great deal of care should be taken in selecting the proper display device and overhead projector so that the presentation can be easily viewed by all the students in a classroom setting.
6. (optional) A color, video digitizer. This device is used to grab and save frames (in real time) as they come from the camera. The digitizer along with a color camera allows a simple method for generating high-quality images. These images are incorporated into the presentation by using LinkWay.
7. (optional) A video camera that generates an RS-170 composite video signal.

Project Description

The course begins by displaying approximately 30 regular topic headings on the computer screen. (See Figure 1.) These topics are described in most of the textbooks on Pascal Programming and Problem Solving [1-3]. The regular topics discuss concepts such as problem solving, programming, data structures, algorithms, and software engineering. In addition to the 30 regular topics, four special topics are also displayed.

(See Figure 1.) These special topics are intended to promote student interest in the subject matter.

Early on in the course, students are encouraged to spend the class time understanding the material presented rather than taking notes. It is explained to them that all of the material presented in class is available on disk. We observed that there were many more questions and discussions as students were attempting to digest the material during the class time rather than merely taking notes in class and then deciphering their notes at a later point in time. We also observed that many students would go to replay the notes immediately after the class while the lecture was still fresh in their minds.

The teacher or student can select a topic and then proceed through that topic at a user selected pace. For example, if a student selects arrays, the program will proceed to the array section and present an introductory discussion of the material. The student can easily move forward or backward through the several screens worth of information. In addition to perusing this basic outline, if the student needs more information on the subject, they can use the mouse to open pop-up windows which provide additional explanations and examples.

Computer Programming One

Course Topics

Understanding Problems
The Eight Dots Problem
The Rate Problem
Matrix Representations
Program Development
The First Program
Variables, Read, Write
Arithmetic Calculations
Assignment Statement
Programming Style
Standard Functions
Procedures
Functions
Selection Statements
Controlling Repetition
Recursion
Arrays
Strings
Two-Dimensional Arrays
Text Files
Records
Variant Records
More About Files
Sets
Modules & Makefiles

Special Topics

Ray Tracing
Image Capturing
Fractals
Graphics

Figure 1. Menu screen for first course in computer science

Next, diagrams and/or pictures which further illustrate the material can easily be included in the presentation. These diagrams are static in nature and are very similar to the types of diagrams that might be found in a textbook. Developing the diagrams and the accompanying text is accomplished with a paint package which is included in the hypermedia package.

Finally, a simulation is run to demonstrate the concepts dynamically. For example, when the arrays simulation is run, the student can actually observe data moving about within the array. The screen is divided into two parts: one side of the screen contains the dynamic simulation; and the other side of the screen displays the program code that produces the data movement. The currently executed program statement is highlighted so that the student is able to correlate the actual program execution with the data movement. This turns out to be a good way of explaining programming concepts because it helps students understand the connection between programming statements and the action that results from their execution. This was the most time consuming part of the package to develop because it involved programming and graphics. However, students greatly appreciated a dynamic explanation of data movement within an array.

A special topics section was added to promote student interest in the subject matter. These special topics include: ray tracing, image capturing, fractal geometry, and computer graphics. In addition to the topics being entertaining, they demonstrate some of the tasks that can be accomplished if students continue on in the major. The ray tracing and computer graphics examples were developed by students in our senior level computer graphics course, the fractal examples were developed by the students with a strong math background, and the image capturing examples were obtained from our image processing course. This is important because many first time programmers often get frustrated with the lack of progress they make during the first course. They comment that it requires so much effort to generate even the simplest programs. It is important for these students to see that with a reasonable additional effort they can create programs that accomplish significant results.

Project Results

This project has been most successful for the following reasons:

1. Students spend more time in class understanding the material presented rather than taking notes. In previous introductory programming classes without the multimedia presentations, students spent so much time copying down information that they missed the subtleties of the presentation.
2. The pace of the course moves more quickly. Without the multimedia presentations, the instructor spends a great deal of time writing sample programs and drawing illustrations on the board. Certainly, this problem could be solved with handouts, however, the time spent developing handouts could be better spent developing the multimedia presentation.
3. The computer simulations added a great deal to the

course. Difficult concepts are illustrated dynamically. These illustrations can be replayed over and over again for greater understanding. It is often difficult to explain in words what is occurring inside the computer. Chalkboard explanations help but they are not very useful in illustrating dynamically changing data structures. The computer simulation can illustrate data movement within the computer and correlate that movement to specific programming statements.

4. We have found that the class notes for the introductory course are also useful in the second programming course. Students are allowed to enroll in the second course if they complete the first course or if they have equivalent credit. We have found that students who come into the second course without completing the first course find the introductory class notes very helpful in filling in any gaps in their knowledge base.
5. When this course was taught without the multimedia presentation the students would spend two hours per week in class and two hours per week in a closely supervised laboratory. The laboratory was needed to bridge the gap between the material presented in class and the practical information needed to get the assigned programs to run. The problems with this method are twofold: there is not enough class time to discuss all the material required for the first course; and the student does not do enough independent problem solving (i.e., the instructor is too available in the lab). These problems are solved with the multimedia presentation. First, the students spend almost three hours per week in the classroom (occasionally they go to lab). Second, there are enough practical examples in the multimedia class notes to bridge the gap between the classroom and the laboratory. Third, without the closely supervised laboratory, students are required to independently solve the homework problems.

Conclusion

As a result of the success of this project, we are in the process of converting other courses into this multimedia format. The authors will happily (and freely) distribute all the developed software to any interested parties.

References

Nance, D.W., and Naps, T.L., *Introduction to Computer Science, Programming, Problem Solving, and Data Structures*, West Publishing, St. Paul, MN, 1992.

Hayes, J.R., *The Complete Problem Solver*, Lawrence Erlbaum Associates, Hillsdale, NJ, 1989.

Cooper, D., and Clancy, M., *Oh! Pascal!*, W.W. Norton & Company, New York, 1985.

* Partial support for this work has been provided by the Howard Hughes Medical Institute, grant number 71191-528601.

Paper (T1.7b)

The Digital World: Teaching Technological Literacy to a Multidisciplinary Audience

Barry Fagin
Dartmouth College
Hanover, New Hampshire

Abstract

We report our experience with the development and execution of a course entitled "The Digital World", designed to increase the fluency and comfort level of non-science students with digital technology. The course relies heavily on computer-aided instruction, including the extensive use of electronic lectures and multimedia. We describe our successes and failures, and present analyses of student performance by gender, class, and field of study.

Introduction

In the fall of 1991, we began the development of a course entitled "The Digital World". Like existing courses elsewhere, this one would teach the basics of digital technology, but with two important differences: 1) it would be accessible to non-science majors, and 2) it would have no prerequisites. Our inquiries at Dartmouth and elsewhere indicated a growing consensus on the importance of technological literacy to a liberal arts education (see for example [NSF86], [NSF89], and [NSF90]). We felt existing efforts were inadequate.

We were also interested in reaching students who would not normally consider taking a science course; those in what Tobias calls the "second tier" [To90]. Tobias suggests that many bright students, particularly women, are alienated by traditional introductory science courses. Reaching these students is critically important in light of expected shortages in scientists and engineers over the next decade [Ma90]. We hoped that by presenting the right material in an application-oriented, interactive fashion, we would be more successful at maintaining student interest. Finally, we were concerned about the monotonous pacing and dry presentation style of introductory science courses, often cited as a reason students leave a technical major [HeSe92].

For subject matter, we chose material from the author's research area: digital technology. We believed that by showing the relevance of digital technology to everyday life, we would be able to teach the basic concepts of boolean logic, information theory, and the limitations of digital systems to an intelligent but non-scientific audience. The project received funding in October 1991, and "The Digital World" was taught for the first time the following spring. This paper presents our experiences and results.

Preliminary Studies

A preliminary examination of the course selections of Dartmouth students showed asymmetry in enrollment patterns. Figure 1 shows the number of humanities courses taken by class of 1989; the horizontal axis shows the number of courses, while the vertical axis shows the number of students. Although not completely flat, there appears to be no statistically significant number of humanities courses that most students prefer; results are clustered fairly evenly from 4-10, and then slightly lower but still evenly from 11-22.

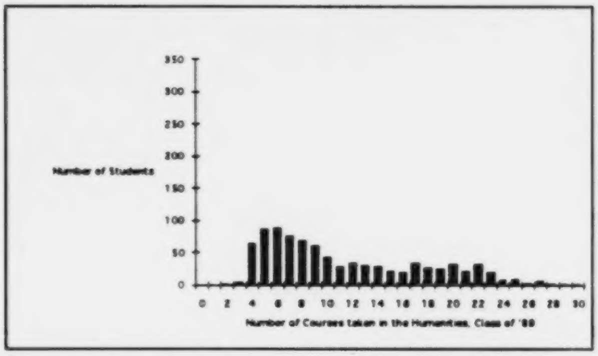


Figure 1: Humanities Course Enrollments [Hi91]

When science enrollments are examined, however, a different pattern emerges. Science course selection is shown in Figure 2. We see that the pattern is strongly asymmetrical, with a spike at the 4-course minimum required at Dartmouth. (Students with less than 4 science courses have received credit and/or special placement).

At first glance, it appears that students are much more comfortable with the humanities, and that when given the opportunity to choose an elective they will choose a humanities course over a science course. Other factors, however, may be at work. Science courses are perceived as requiring more effort for a comparable grade than humanities courses. This may discourage students from taking scientific electives. However, our survey of the curriculum noted that there were very few

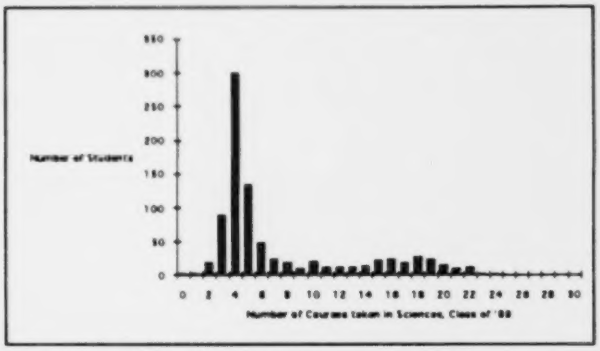


Figure 2: Science Course Enrollments [Hi91]

science courses available with no prerequisites, particularly for non-science majors. Thus the shape of figure 2 could reflect not only student apprehension about the sciences but a lack of enrollment choices consistent with background and ability. Perhaps optimistically, we assumed the second factor was at least as important as the first, and began the development of "The Digital World" accordingly.

Student Population

A total of 20 students signed up for "The Digital World". Breakdowns by gender, year, and major are shown below:

Gender	*Class*	*Major*
Female: 5	Seniors: 7	Sciences: 8
Male: 15	Juniors: 4	Other: 11
	Sophomores: 3	Undecided: 1
	Freshmen:5	

Table 1: Breakdown of Course Enrollment

The ratio of women to men in the course, while less than that of the College as a whole, is typical of science courses at Dartmouth. Surprisingly, the age distribution of the students was fairly even; we had expected mostly freshmen and sophomores.

We were also surprised at the large number of science majors in the course. On the one hand, it may be that we were not as successful at attracting non-science majors to the course as we would have liked. On the other hand, and perhaps more accurately, science majors may have found the course too attractive to pass up. College-wide graduation requirements mandate the selection of a certain number of science courses outside the major, even for students studying the sciences. Thus certain science majors looking to satisfy this requirement might find "The Digital World" to their liking, particularly if the material is not far from their field of study. As evidence of this, we note computer science was the best-represented major in the course, with 3 students.

Course Content

"The Digital World" met three times a week, and contained a total of 28 lectures. The topics were divided as follows:

1. *Fundamentals: 6 lectures.* Discrete and continuous phenomena, binary notation, boolean algebra, logic gates, basic circuits.
2. *Digitization of sound: 5 lectures.* Pulse Coded Modulation, Error Correcting Codes, how Compact Discs work.
3. *Digitization of images: 6 lectures.* Bitmapped, grayscale, color images. Animation, image compression, HDTV.
4. *Computers and related devices: 3 lectures.* I/O devices, memory, microprocessors.
5. *Special topics: 6 lectures.* Discrete information transmission in living systems (DNA), assistance with course project, miscellaneous topics taken from the popular press.

One lecture was reserved for an in-class midterm, and one lecture was held in an electronic music studio. The course project required each student to develop a finite state table for playing tic tac toe. Software was provided to simplify the task and to test student tables, which played against each other on the last day of class. Grades were based on homework assignments, a midterm, a final, and the project.

Use of Computers and Multimedia

The material covered lent itself extremely well to computer-based presentation; it is safe to say that the concepts could not be effectively demonstrated without them. We present below some brief examples of how computers and multimedia were used. All material was developed and presented using a color Mac II with 4MB of RAM, running System 7.0 with the QuickTime extension.

1. Lectures and course administration: All lectures were developed and presented electronically as Hypercard stacks (version 2.1). Lectures were made publicly available on a file server before class for students to download and print. Students could also execute the lectures on their own machines, at their own pace and at times of their own choosing. Homeworks and other course-related materials were distributed electronically, and students were encouraged to use e-mail to communicate with the instructor in addition to scheduling office hour visits. Students reacted very positively to the extensively computerized format, regardless of background.
2. Application programs: Numerous application programs are required to present the material of "The Digital World". Programs used included the following:

   Gates of Logic. Uses graphics to demonstrate principles of boolean logic. Developed by Prof. Jim Moor, Department of Philosophy, Dartmouth College. Available by request.

Logic Works. Simple circuit design and simulation. Site licensed.

Image. Image processing program from NIH. Demonstrates effects of varying image quantization, filtering, color maps and lookup tables.

QuickGif. GIF image viewer. Public domain.

JPEG. Converts GIFs to JPEGs. Public domain.

JPEGView. JPEG viewer. Public domain.

Simple Player. Mac software for QuickTime animation. Bundled with System 7.0.

Lookup tables are used for reducing the amount of memory required by an image. The acronyms GIF and JPEG refer to image compression techniques. They also refer to images compressed using those techniques.

3. *Sound and image processing.* Much of "The Digital World" is concerned with the digitization of information, particularly sound and vision. The use of multimedia permits the class to hear the effects of varying sound quantization levels, to see how digital images can be altered, how light blends to give color, how motion can be digitized, and so forth. There is simply no way to demonstrate these concepts without a multimedia-based environment.
4. *Project development and in-class tournament.* Students completed the course project using software developed on a workstation running X/Unix. Assignments were returned to the instructor electronically, and made to compete against each other on the last day of class. This was done interactively, with the students watching the progress of each game on the screen.

Student Performance

A breakdown of student performance by three categories is shown below:

Men: 85.1	Seniors: 87.6	Science majors: 89.4
Women: 89.6	Juniors: 82.6	Non-science majors: 76.5
	Sophomores: 87.6	
	Freshmen: 86.7	

(Data from one student with a significantly lower grade than the rest of the class is not included here).

Table 2: Student Performance (out of 100)

Although the sample size is small, some features of Table 2 remain surprising. First, the women in the course performed significantly better than the men, despite the fact that only 2 of 5 were science majors. This suggests that deliberate efforts by the author to remove aspects of classroom instruction known to alienate women may have had a positive effect [To90]. The author is embarrassed to admit his astonishment when, after the grades were tabulated, he discovered that the top 2 students in the class were women.

We also expected upperclassmen to perform better than freshmen, and were surprised to find no significant difference in performance between the grades. Only two juniors were included in the sample set of Table 2, so we are reluctant to conclude much from the lower junior grades.

Without a doubt, however, our biggest disappointment was the significant difference in performance of the science majors. Despite our efforts to set up a course that non-scientists could take and excel in, students who majored outside the sciences had a much harder time.

Grades were not curved, so the performance of science majors did not affect other students. It is possible, however, that the presence of students from scientific backgrounds who were obviously comfortable with the material may have intimidated students from the humanities. Humanities students may also have had more difficulty assimilating material from what is essentially a different culture. We will try to address this problem in future versions of the course.

Conclusions and Future Work

Student response to "The Digital World" was quite positive, despite varying student backgrounds and the inevitable problems with the first offering of a course. A detailed summary of written comments, both positive and negative, is provided in the Appendix. Readers are in particular referred to the last portion of the student survey, in which students were asked to evaluate the effectiveness of computers and computer software. We note that many of these students come from a humanities background, and had expressed some concerns with taking an engineering course.

In light of student feedback and our analysis of the course, we regard the following aspects of "The Digital World" as a success:

1. *Addressing gender-based gaps in performance.* Women outperformed men in "The Digital World", possibly due in part to deliberate efforts by the instructor. This included calling on students in a truly random fashion (using a computer-based random student selector) and employing a highly interactive teaching style. The content of the course may also have helped; it was made very clear in the catalog that this would not be a standard introductory science course.
2. *Use of multimedia.* Students responded very well to the use of computers, application programs, sound, image, and animation demonstrations. Students were already familiar with the Macintosh, and had little difficulty in exercising its multimedia capabilities.

3. *Implementing a non-trivial programming project.* Almost all students completed the tic-tac-toe project, and most of those that completed it received a perfect score. We believe this is due to the use of a finite state table instead of a programming language to express the desired functionality.
4. *Choice of material.* Students responded very well to the material on CD's, the Macintosh, and HDTV. Both science and humanities majors asked very sophisticated questions in these areas, questions that went beyond the planned presentation of the instructor. The importance of introducing theoretical material with accompanying applications familiar to the student cannot be overemphasized.

We regard the following aspects as unsuccessful, or at least needing further improvement:

1. *Reducing the correlation between field of study and performance.* We had hoped to see non-scientists perform as well as students from the sciences. This objective was not achieved.
2. *Producing a paperless course.* Although the vast majority of material in "The Digital World" was electronic, students printed out complete lectures and brought them to class. This often produced more paper than if the lectures had not been electronically available in the first place. It also created a strain on public printing resources.
3. *Incompatibilities between students and instructor platforms.* Due to differences between student and instructor computing platforms, students had occasional problems in viewing lectures and executing programs on their own machines. This led to frustrating experiences in which students blamed themselves for their machine's inability to execute a piece of software.

We have several plans for future versions of the course. We hope to incorporate still more multimedia-based material into the lectures, and to write our own custom application programs better suited to the concepts we wish to illustrate. We will concentrate very carefully on students from outside the sciences, emphasizing repeatedly that they can master all the material covered in class if they abandon any preconceptions they have and apply critical thinking skills.

Our most ambitious plan calls for replacing the software project with a chip. Students will create finite state tables, as before, but these tables will be used to program a field programmable gate array that lights LED's appropriately in response to input moves. Students will thus be able to design their own chips that play tic-tac-toe. In addition to providing a more tangible reward than the previous project, this may help address student concerns about project relevance (see Appendix).

All course materials produced for "The Digital World" are available for public distribution. We anticipate further refinements and greater availability after we offer the course a second time, in the spring of 1993.

Acknowledgements

Funding for this project was made possible by a grant from the New England Consortium for Undergraduate Science Education, and by the National Science Foundation's Undergraduate Course and Curriculum Development Program through grant #USE-9156226. The author is also grateful for the use of equipment supplied by Apple Computer Corporation. Finally, thanks are due to Professor Jim Moor of the Dartmouth Department of Philosophy for development of the Logic Works application program, and to Professor Jon Appleton of the Dartmouth Department of Music for his demonstration of the Bregman Electronic Music Studio.

References

Hewitt, N. and Seymour, E., "A Long, Discouraging Climb", *ASEE PRISM*, February 1992, pp 24-28.

Hitchcock, Charles et. al., Report of the Task Force on Curriculum Development for Technological Literacy, Thayer School of Engineering, Dartmouth College, March 1991.

Malcolm, S., "Who Will Do Science in the Next Century?", *Scientific American*, February 1990, p 112.

Undergraduate Science, Mathematics, and Engineering Education/ National Science Foundation, National Science Board Task Committee on Undergraduate Science and Engineering Education, H. A. Neal, Chair—[Washington, DC]: National Science Foundation, 1986-1987. NSF Pub. No. NSF 86-100.

Report on the National Science Foundation Disciplinary Workshops on Undergraduate Education: Recommendations of the disciplinary task forces concerning issues in U.S. undergraduate education in the Sciences, Mathematics and Engineering/Division of Undergraduate Science, Engineering, and Mathematics Education, Directorate of Science and Engineering Education—[Washington, DC]: National Science Foundation, 1989. NSF Pub. No. NSF 89-3.

Report of the National Science Foundation Workshop on the Dissemination and Transfer of Innovation in Science, Mathematics, and Engineering Education: Division of Undergraduate Science, Engineering, and Mathematics Education, Directorate for Education and Human Resources, National Science Foundation, May 1990. NSF Pub. No. NSF 91-21.

Tobias, S. "They're Not Dumb, They're Different: Stalking the Second Tier", Research Corporation, 1990.

Wineke, W.R. and Certain, P., The *Freshman Year in Science and Engineering: Old Problems, New Perspectives for Research Universities.* A report of a conference sponsored by The Alliance for Undergraduate Education with support from the National Science Foundation. [University Park, PA]: The Alliance for Undergraduate Education, 1990.

Appendix: Student Comments

This appendix contains written comments, both positive and negative, supplied by students on their course evaluation forms. These forms are filled out before grades are assigned.

What aspects of the course did you like most?

Imaging demonstrations in class.

I liked the fact that we were introduced to a wide range of topics. The project was fun. I liked the fact that lecture notes were available by computer and that some of the assignments required us to figure out how to use different things on the computer.

I really liked the material. It was a great way to learn about technology without being thrown into high level engineering. It was very organized and the problem sets were helpful, too.

Hypercard learning tool. No outside reading—perfect for dyslexics. Prof. Fagin's great explanations and teaching method.

Learning how things worked (i.e., CD's, computers, etc.). Viewing some of the new image and animation capabilities of the Mac.

I liked the pace at which the course moved, it did not become "bogged down".

The final project was interesting and inspiring. Use of computers in all aspects of the class.

The digital music section—especially seeing the digital music lab.

Interactive lectures, depth to which topics were covered, range of topics covered, good pace of progression from binary to use of binary, circuits to CD's, etc., use of Macintosh as a teaching aid.

Course material format and organization of lecture sequence.

Subject matter itself.

I liked the beginning lecture material on binary notation and algebra. I liked making circuits and learning about CD's, cassettes, computers, etc. (utilitarian objects)

Material, lectures on computer.

The areas that we studied were all very interesting, and I definitely enjoyed learning about them. Help was readily available and I didn't feel as pressured to remember everything as I am in some other courses.

I liked Prof. Fagin's teaching style and lectures on the server—this was especially useful if some aspect of a lecture was unclear because it was easy to reread the notes as necessary.

What aspects of the course did you like the least?

Project, lecture notes on computer.

I think we should have spent more time on computers and learning in a little more detail about how they work. It would have been interesting to have learned a little more about computer viruses.

The project was fun to do, but I'm not sure now applicable it was to the material. It was kind of a tedious exercise. For future classes I think there should be a different project.

TA grading style—too harsh at first, probably because she didn't attend lectures and was not always clear on what students did or did not know.

The project seemed to have little to do with any major aspect of the course.

More "lab" type work would be nice, actual circuits and such.

The absence of a text.

More depth with logic gates would be helpful—maybe seeing a real chip would be helpful also.

Not enough information on the topics to be focused on for the exam. Class was way out here in Cummings.

Class discussions fairly limited. Class participation limited to being called on during lecture and to final project. Student input during lectures was kept brief and not allowed to expand into discussion.

What I didn't like was how the second half of the course was taught. I can't really explain, but I couldn't grasp the information as well as I did during the first half.

Homeworks—poorly written and extremely unclear.

Organization could have, perhaps, been a little better.

I felt at times the class was too easy, but then again this may have had to do with my background—I feel I have a very strong science background and I found that the class required very little time.

Please comment on the effectiveness of computers and computer software as learning aids in this course.

Lectures on computers were hard to read and thus I got a headache.

Very effective / Excellent

Computers were very well used in this class. Prof. Fagin did a great job of incorporating them into lectures, homework, and the project.

The computer lecture method was extremely effective and easy to learn by. All the demos, homeworks, and projects involving computers were effective tools for this course.

Useful for images, etc., but lectures were a serious hassle to view on Hypercard.

Very effective, especially NORTHSTAR use. Hypercard lectures were very helpful.

Excellent—actually could have used lecture Hypercard stacks more in class.

Very effective—although I took notes—having lectures on Hypercard facilitated review and ensured that I would not miss important information. Tic-Tac-Toe program was easy to use and had a nice looking interface.

Computer was used effectively in class, when it was used. Lectures were clearer and better organized when presented through the computer display.

Computers were an integral part of the lecture and note-taking process of this course. However, I would consider them to be more informative sources than they were learning aids.

Extremely effective—vital part of the course.

It was quite useful and would have been much harder to understand without computers.

The Tic-Tac-Toe game was fun but I'm not exactly sure how it related to the course.

Paper (T1.7c)
Preliminary Evaluation of IDG Technology for Distance Education in Alaska

Peter J. Knoke
University of Alaska, Fairbanks

Abstract

After a successful use of first generation Interactive Digital Graphics (IDG) technology for distance education in 1986, a second generation IDG platform has been put into use recently for distance education in Interior Alaska. This is a preliminary report on the evaluation of that technology.

It is based on results from a recent (Spring '92) offering of a computer literacy course to three students at a single remote site, and a current (Fall '92) offering of that same course to nine students at three remote sites concurrently.

In the pilot offering nearly everything went well. This successful experience gave rise to the present ongoing offering to nine students at three sites (Fairbanks to Fort Yukon, Nenana, and Tok). After a rough start due to Mother Nature problems, the multiple networked platforms have been working well and the students appear to be happy and learning a lot. So, this multi-site version of the course has also been quite successful.

Following a brief description of the project's background, related work, the computer literacy course and the IDG technology used to deliver it, this report covers data gathered from both course offerings. Problems, solutions, and lessons learned are covered. A discussion section addresses a number of issues including possible IDG platform improvements.

The conclusions so far are that the networked IDG platforms worked well for distance delivery of CS 101 for both single and multiple concurrent remote site offerings. Effective use of the IDG technology requires the development of a number of operational procedures and certain elements of teaching style. Many of these procedures and elements may have to be invented by the instructor.

The prospects for the continued use of this IDG technology or derivatives thereof in Interior Alaska distance education applications appear to be good.

Introduction

In Spring 1992, the University of Alaska Fairbanks (UAF) provided distance delivery of a computer literacy course called CS 101 (Computers and Society) via Interactive Digital Graphics (IDG) equipment. The course was offered to the remote site at Fort Yukon, Alaska on a pilot basis. The purpose of the offering was to meet the stated educational objectives while also providing data for the continuing evaluation of the IDG platform. The course was taught by Drs. Knoke and Kendrick, both Associate Professors of Computer Science in the Department of Mathematical Sciences.

The IDG platform used was considered to be a second generation platform for Alaska, because there had been prior successful experience with a much simpler IDG platform (a first generation platform) in Kotzebue in 1986 [MOORE87].

The purpose of the team teaching in this pilot offering was partly to reduce the teaching overloads on the two professors invoived (neither of whom was reimbursed for the teaching effort), and partly to provide two viewpoints instead of just one on the IDG platform suitability and effectiveness in this application. Although there were then four available remote sites with operational IDG platforms (Tanana, Nenana, and Tok in addition to Fort Yukon), only one site was used for the pilot offering. This was done deliberately to increase the chances of success in this first CS 101 distance delivery effort. Neither Knoke nor Kendrick had any prior experience with distance education delivery via IDG. Both instructors had taught the Fairbanks campus version of CS 101 several times, however.

The Spring '92 one-remote-site CS 101 via IDG was quite successful, and this successful experience gave rise to the three-remote-site version now being offered in the Fall '92 semester. In this case, there is only one instructor (Knoke).

The multi-site offering has gotten off to a rough start because of problems due to Mother Nature (heavy September snowfalls leading to widespread power outages). Nevertheless, so far the multiple networked IDG platforms have been working well and the students appear to be happy and learning a lot. Final results won't be known until mid- December 1992, however.

The remainder of this paper consists of 11 sections,as follows. Section 2 (Background) gives a brief idea of some distance education issues in Alaska. Section 3 (Related Work) addresses some generic questions about related work and provides references for those interested in further details. Section 4 (Course Description) gives a brief description of the CS 101 course for which the IDG was the distance delivery vehicle. Section 5 (IDG Technology Description) is a summary description of the salient features of the IDG platform and the network used. Section 6 and Section 7 describe Course Delivery Results and Problem Areas, respectively. Sections 8 and 9 cover Lessons Learned and Discussion. Section 10 is a Summary and Conclusions, while Section 11 acknowledges the efforts of key people who have helped to make this year-long evaluation a success. Finally, Section 12 is a list of references.

Background

With an area of nearly 600,000 square miles and a population of just over 500,000 people, Alaska has 16% of the area of the USA and only 0.2% of its population. The three cities of Anchorage, Fairbanks and Juneau, forming roughly an isosceles triangle with legs of 350 miles, 800 miles, and 800 miles, contain about 50% of the population. The remainder of population is contained in about 287 named communities with populations ranging from about 8000 (in Sitka) to 8 (in Cape Takataga) [ALASKA90]. Many of these communities can't be reached by road, but only by air, water, or dog sled (perhaps, snow machine). Because of this size and population distribution, there is a great need for distance education in Alaska. Therefore, it isn't surprising that many distance education technologies have been and are being used in Alaska today (e.g., audio conference only, audio plus one-way TV, audio plus E-mail, audio plus IDG, and closed circuit TV).

The best distance education technology to use depends on a number of factors, of which location is an important one. This paper concerns distance education delivery in Interior Alaska, a large area for which Fairbanks is roughly the center. This area can be characterized as having about 200 small (few hundred population) villages that are widely separated and frequently difficult to access. IDG networks used in combination with audio conference appear to be a natural technology for this educational environment. However, note that this issue ("best distance education technology") is the subject of perennial debate in Alaska. Some of the flavor of this debate can be found in [CHUGACH9*] and [THOMAS92]. Two other simpler-than-IDG technologies that have been used with good success in Alaska for years are audio conferencing and Email [OHLER91].

Related Work

One of my objectives in undertaking this project was to evaluate the cost-effectiveness of IDG technology for quality distance education. Another objective was to have an educational adventure, exploring the unknown with the unfamiliar IDG teaching tool. An adventure it certainly was. Some of my (printable) teaching experiences are described in another paper [KNOKE93].

In the area of related work, three generic questions should be asked of this paper. Those questions are listed below together with my responses.

1. How does this project compare to similar studies done elsewhere or at other times?

In the area of distance education via IDG in Alaska, [MOORE87] and [HILLS92] are the only two documented studies of which I am aware. In the first one Greg Moore reports his success with the use of first generation IDG technology in the distance delivery of university level mathematics to villages in the Kotzebue Alaska area. In the second one, Greg Moore and Alex Hills collaborate in describing the selection process for and the characteristics of the second generation IDG technology and network that was used in my project. This IDG network was acquired, installed and maintained by the University of Alaska Computer Network (UACN), and UACN referred to the associated project as the Alaska Telegraphics Project. Greg was Manager of the Alaska Telegraphics Project, while Alex was Executive Director of UACN. My debt to Greg and Alex is noted in Section 11.

I can't prove that this project doesn't "reinvent the wheel" from a distance education point of view. Instead, I offer the following solicited comments from Barry Willis (Director of Statewide Distance Education, University of Alaska Statewide (see [Willis92A], and also [WIillis92B]).

> There have been hundreds of projects that have sought to meet the needs of rural, multi-cultural, and non-traditional learners through the use of technology at a distance. As for the use of audio-graphic (IDG) technology towards this end, I'm sure some projects have been completed somewhere... Regardless, the research shows that (success is likely) so long as the technological capabilities are appropriate to the task at hand (e.g., visual technology is needed if students must actually "see" something).
>
> So the questions to ask are these: What are the needs of the students, the requirements of the content, the teaching style of the instructor, and the limits of the technical delivery system?
>
> Once these questions are answered, the task is to pick the most appropriate mix of technologies to meet the needs.
>
> To me, the intriguing thing about your (the Alaska Telegraphics) project was not so much the technology used, but the fact that all of the "right" questions were asked before the delivery system components were finalized.

Concerning the IDG technology itself I call attention to the [IISTECH91] and [JESSUP93] references listed. The first is the GTCS User Guide (GTCS stands for Groupware Telecommunications Software). Note that a new version of the GTCS software has been released recently, but I haven't yet had an opportunity to evaluate it. The second reference is to an edited collection of papers on Group Support Systems (GSS).

Recently, interest in GSS has been both strong and increasing, with much of the interest arising from the business community. Perhaps distance education practitioners now have an opportunity to "ride the coattails" of a technology thrust that is largely financed by business interests (i.e., by someone else).

Concerning particulars of the IDG technology, note that two different IDG platform/software combinations are now in use in Alaska. The platform used in this study was PC-based and uses the GTCS software. I call it the UACN IDG platform. In addition to its use for remote delivery of CS 101 as reported here, this UACN platform was successfully used at UAF by Gary Gislason for the remote delivery of Math 107 (Elementary Functions). I've had several conversations with Gary regarding his UACN IDG use results and problems [GISLASON93]. Generally, the platform worked well for him. He has experienced significant problems with his math delivery project, but most of them have little to do with the IDG technology itself. For example, one of the problems is that many people at the designated remote site don't like and don't want to learn math.

The other IDG platform/software combination now in use in Alaska is the Telewriter product from Optel Communications. I refer to this IDG as the Kuskokwim IDG, because that is the geographical area of Alaska where it is being used. I've heard reports of the successful use of this platform for distance education with different subjects, e.g. English writing, but I've seen no written reports providing details of these successes.

Note that in Alaska at present, the policy is that distance education technology selection decisions are left to the selecting education regions. Of course this policy gives rise to debates regarding who selected the "best" technology and why. The debates include not only subjects like the UACN IDG vs. the Kuskokwim IDG, but also such subjects as Email vs. IDG, Non-Interactive TV vs. IDG, IDG vs. voice conferencing, etc. These interesting and ongoing debates are beyond the scope of this paper. Examples of some of them can be found in [CHUGACH9*].

[THOMAS92] is Doctoral Dissertation on the history of educational telecommunications in Alaska. This provides further context for the present paper, and additional discussion of the topics mentioned in the paragraph above.

2. Considering those similar studies, what were the areas of strong correlation?

Perhaps a common factor for successful distance education projects is that a good requirements study preceded the technology selection in most of them [WILLIS92A].

Also, perhaps a common factor for failed distance education projects is that a good requirements study did not precede the technology selection in most of them. In the past, Alaska has been the site of some "world-class" distance education project failures [THOMAS92].

3. Considering those similar studies, what were the areas of major differences?

Greg Moore reported success using first generation IDG technology to teaching math ([MOORE87] and [CHUGACH91]), while I am now reporting success using second generation (UACN IDG) technology to teach computer literacy. Gary Gislason also reported success using the UACN IDG technology to teach math. Finally, I've heard of reports of the successful use of the Kuskokwim IDG to teach English writing.

So, we have data regarding several cases of similar studies using different IDG technologies for the distance delivery of different courses. Unfortunately I have too little data at present to support any firm conclusions in this area.

Course Description

CS 101 is a typical computer literacy course, featuring what some call the 3 R's of computer literacy (computer knowledge, awareness of computer impact, and hands-on experience with computers), and using lectures and computer laboratory exercises to provide them. The challenge is to provide this via distance delivery.

The full syllabus for CS 101 (Computers and Society) is provided in [Knoke92]. Some selected details are provided below.

UAF Catalog Description

Computer literacy for everyone. Overview of computing machines and automatic data processing. Interaction between social institutions and automated decision making. Some programming for understanding, not for skill development. [Prerequisite: Two years of high school mathematics, including at least one year of algebra. 3 credits.]

Knowledge Objectives

Understand basic computer hardware and software concepts. Why computer systems are useful, and some of their limitations and problems. How to select computers and their software (mostly PC's). The social impact of computers.

Skills Objectives

Learn the basic use of Email and all the Microsoft Works tools (word processing, spreadsheet, charting, database management, communications, and tools integration). Learn to write simple programs in BASIC.

Exams

There are three in-term exams and one final exam. All exams are open book and open notes. Questions are mostly of the objective type.

Lab Assignments

There are 12 required lab assignments covering Email, Electronic File Transfer, Works and BASIC.

UACN IDG Technology Description

In selecting its second generation UACN IDG technology, the University of Alaska chose from three IDG software packages on the market in 1990: the Telewriter product from Optel Communications, Inc.; AT&T's Scanware (no longer on the market); and Group Telecommunications Software (GTCS) from IIS Technologies, a subsidiary of Bell Canada. All three packages performed the required operational functions, but the details of their operation differ. The University of Alaska selected the GTCS offering, believing it to be best. As has been noted, the Kuskokwim IDG presently uses the Optel offering.

The UACN IDG technology presently being evaluated is an IBM PC-based platform with a modem, a graphics tablet with pen, a scanner, a laser printer, and (in some cases) a TV camera as peripherals. The key to its functionality and performance is the GTCS package.

The essential paradigm implemented by the network of communicating IDG platforms is that of a shared blackboard. In this network, all platforms are peers and all can write on the blackboard simultaneously. Confusion regarding who is writing is reduced by the use of selectably different colors at different sites.

The UACN IDG network configuration is of the star type, with the central element called a data bridge. In this case the data bridge was developed by IIS Technologies Inc., a Bell Canada Company [IISTECH91]. It consists of IBM PC-based hardware and software, and it costs about $15,000. To implement the networking it uses the Multipoint Communication Service (MCS) protocol, a communications software package developed by Bell Northern Research (BNR). This protocol allows connections by dial-up modem, X.25 network, IEEE 802.3 and NetBIOS LANs, synchronous and synchronous networks and ISDN. However, the UACN IDG network presently uses only dial-up modems. Although MCS is not now an official conference standard, in 1992 BNR submitted it to CCITT Study Group XIII as a candidate for adoption as an official standard.

A typical UACN IDG platform consists of the following:

- IBM PC/AT-compatible 80386 computer with 2-Mbyte RAM and a 40 Mbyte hard disk.
- 20-inch, 16-color VGA monitor.
- Graphics tablet with cordless stylus (12 x 12 inch Wacom 420SD)
- Black and white document scanner (Canon XJ12)
- 9600-bps synchronous modem (Universal Data Systems V.3225)
- Black and white printer (HP Laserjet 3).
- Video camera (only at some sites—JVC TK870OU, interfaced with AT&T Targa card).

In an operating UACN IDG network the computer at each site runs its own copy of the GTCS software. The data bridge uses the same computer with a set of the same 9600-bps modems, one for each connected telephone line. Thus, for a conference with 8 participating IDG platforms the bridge computer must have 8 connected modems. The bridge computer runs the MCS bridging software.

Course Delivery Results

As was noted above, the one-site pilot version of CS 101 was completed in Spring 1992, while the three-site version is now underway. Results from the two cases are presented separately.

One Remote Site—Spring 1992

In the one-site pilot delivery, the IDG technology performed very well. The IDG platform was found to be particularly well suited for CS 101 delivery because the platform is itself a suitable object for study in that course.

There is no really bad news to report about this pilot distance delivery effort. Three students stared the course, but only two completed it. The student who dropped out did so early in the course for unknown reasons.

The one-site course was successful by several different measures. The students reported that they liked the course (the Fort Yukon Center Director Carolyn Peter used the expression "raved about"). The two professors felt that the two students who completed the course enjoyed it, worked hard and learned a lot. This impression is based on attendance records, assignment records, exam grades, and direct observation (see [KNOKE92] for details). Finally, both professors found the IDG equipment easy to operate, effective, and highly compatible with this particular course.

The average attendance for the two students completing the course was 75%. This level compares favorably with average attendance for the on-campus version of CS 101.

Supervised hands-on computer use is a major feature of the on-campus version of CS 101. It was a challenge to provide its equivalent on a remote basis. One method that worked well was the use of the IDG platform with the platform-to- platform direct link broken, but with the audio line maintained. With this configuration, if the instructor and the remote site did the same tasks at the same time (e.g., debugging the same BASIC program on the UAF VAX, or running the same IDG-based Microsoft Works tutorial), then the instructor is in the desired position of "peering over the shoulder" of students as they perform hands-on tasks.

Three Remote Sites—Fall 1992

The three-site offering now underway has the instructor at Fairbanks with students at Fort Yukon, Nenana, and Tok. Also, there is a manned IDG at the data bridge for support at every session, plus another at Anchorage for occasional additional support when needed. In other words, in a typical session there were 5 networked IDG platforms, and on some occasions there were as many as seven.

The three-site CS 101 offering got off to a shaky start in September 1992 because of problems due to Mother Nature. A heavy early-season snowfall caused still-leafy trees to bend and fall onto power lines. This led to a days-long period of electrical power interruptions and outages over a wide area in Interior Alaska. Of course the IDG platforms won't operate without electrical power, and remote sites don't have Uninterruptible Power Supplies (UPS) at present.

These initial start-up problems were overcome with the aid of technical support from people other than the instructor, using other IDG platforms at the IDG data bridge and in Anchorage plus the audio conference and regular telephone facilities. The occasion provided an extraordinary example of IDG-aided distributed group problem solving. However, it isn't clear that it was perceived in this favorable light by the frustrated students.

After this troubled beginning, the IDG network soon became stable. However, a technical support man continues to be needed to stand by at the IDG data bridge for every class. From this position he has excellent network visibility, and he is able to assist sites with any problems that may arise. We had hoped that his support services would become unnecessary as the semester wore on, but in fact his assistance was needed at least once during most sessions. The most common continuing network problem was intermittent dropouts of the IDG platform at Tok. It was conjectured that these dropouts were at least partly caused by the telephone equipment at Tok, but their exact causes are not known with certainty. A single-site dropout is normally easily corrected by re-booting the IDG PC at the effected site while the main conference group continues. However, this process is noticed by and mildly annoying to the other conference participants. Of course it is quite disruptive to those at the dropped out site.

Generally the audio conference component of the IDG system has emerged as the most reliable network component because it continues to operate in spite of power outages and site dropouts at the data bridge. However, without the IDG data a remote site is essentially blind, and the conference becomes an audio-conference-only for that site. A session planned for full IDG use is perhaps best canceled at a site that has lost its IDG data, because the audio-only version is unlikely to be educationally effective there when the other sites continue to have IDG data plus audio data. However, there are some exceptions to this as noted below.

During the troubled start-up phase, some interesting network configuration asymmetry cases were encountered as a result of various kinds of site capability outages. For example, during an early session one site had IDG data ("eyes") but no audio conferencing ("ears"), while another site had the ears but not the eyes. In that case it was possible to continue effectively by having different sites doing different activities, with both monitored by the instructor via audio. The key here was instructor and student flexibility. It was also helpful that all parties concerned had a high frustration tolerance.

With the painful start-up difficulties in the past, the multi-site IDG network has now become quite stable and the educational results so far are good. The latter remark is based on my review of examination results and of lab assignments, and on my subjective assessment of the dynamics of typical class sessions There were initially 9 students at 3 remote sites, and at this writing it appears that most of them will complete the course with good grades. Attendance has been about 75%, a figure which compares favorably with attendance at the UAF campus version of CS 101. Students appear to be enjoying the course and enjoying their hands-on operation of the IDG platforms.

Problem Areas

This report is only a preliminary evaluation of the IDG technology, and the identification and analysis of apparent problem areas is not rigorous. Perhaps this section should be called "perceived" problem areas, because in some cases the cause of the problem is not known with certainty. The area called "intermittent dropouts" is an example of this. So, the reader is advised to be cautious in interpreting the data in this section.

Mother Nature

In Interior Alaska Mother Nature is a strongly felt presence and a constant source of problems for the IDG sites. Fort Yukon, for instance, is north of the Arctic Circle and winter temperatures there routinely drop -55 degrees F and lower. Moreover, Fort Yukon is located on the north bank of the mighty Yukon River which routinely floods every spring. Thus it's helpful to mount the IDG equipment on an easily moved platform such as a strong cart with wheels so that it can be easily moved to avoid flood waters. Closer to Anchorage, active volcanoes erupt with ash effects that cause equipment outages. In short, Mother Nature provides a tough environment for IDG technology tests in Alaska.

Possible Design Bugs

Apart from Mother-Nature-induced problems, the IDG network and its associated software may have some design bugs in need of correction. For example, if a local site attempts to print a screen during an active conference, then that site is likely to get knocked out of the conference. The dropout appears to be caused by the hard-copy attempt. However, the true cause of this problem is not presently known. Whatever its cause, this problem is an example of one that can be handled effectively and easily by suitable Standard Operating Procedures (SOP's). The appropriate SOP here is to refrain from making hard-copy at a site while the IDG platform is on-line in a conference.

Novice IDG Operators

Some IDG operational problems arise from novice IDG operators. Such operators can touch the wrong icon, or push the wrong button, with effects that can be disruptive either locally or conference-wide or both. As an example, the zoom (screen enlargement) capability can be enabled and then invoked at a site by pressing a button on the cordless pen. However, once the capability is enabled, inadvertent disruptive zooms become quite likely. These events may seem to be locally disruptive only, but if the problem has to be solved by the instructor at a remote site the disruption becomes global. The appropriate SOP here is to disable the zoom capability after use. With multiple sites, a peer network, and novice users, there is a also a likelihood of inadvertent sending of images from one site to all the others. A possible SOP to avoid this is to discourage IDG manipulations at the remote sites, but this SOP isn't desirable because the interactive actions are the very actions that the instructor is trying to encourage (to get active instead of passive learning). Such problems can be minimized if there is a moderately experienced IDG user or "facilitator" at each site. Such a person inevitably emerges after a while, but the start-up period with all novices at an IDG site is a classical bootstrapping situation.

Communications Costs

According to Barry Willis, distance education may be cost-effective but it is NEVER inexpensive [WILLIS92A]. One of the UACN IDG technology problems perceived by educational administrators is that of high IDG-related phone bills. Here are some facts and some estimates about that.

Typical direct operating costs for an IDG platform operating in Alaska include about $22/hour for telephone costs. About half of that is for one phone line for the audio conference, while the remainder is for the other phone line to the data bridge. Since a one-semester course requires about 45 instructional hours, the estimated phone bill is about $1000 per site per course. Thus the phone bill for running CS 101 in Spring 1992 was about $2000, while the phone bill for running CS 101 in Fall 1992 will be about $4000 (NOTE: these cost figures and other cost figures mentioned in this section are estimates only, and they are probably not very accurate. They are included to convey the general nature of the communication costs problem, rather than it's exact size). As was noted earlier, the use of a multiplexor to cut these communications costs in half is a possibility that is being explored. However the present UACN IDG platform doesn't include such a device.

In future IDG-based course offerings, per-site INSTRUCTIONAL costs can be kept low by the use of multiple concurrent sites (they were $0 for this CS 101 project because both the Spring and the Fall courses were taught on an overload basis, i.e. for free). However, no such economy of scale is likely for the per site COMMUNICATION costs , which will tend to be about the same until either Alaska phone rates are reduced or a multiplexor is added at each platform or both. Moreover, the per site per student communications costs will tend to remain at the present level of roughly $5/hour/student. Note that the IDG platform design is such that the number of students per platform should be a maximum of about four in order to preserve the desired interactive character. Therefore, an increase in the number of students at a particular site will only result in a requirement for an increased number of IDG platforms at that site.

Lessons Learned

At this writing the second CS 101 course offering is not complete, and many lessons are still being learned. Thus the list of lessons that follows is both incomplete and evolving.

Lesson 1: Stay Flexible

Distance education in the Bush of Interior Alaska is nothing if not "interesting". (There is supposed to be an old Chinese curse which goes "may your life be interesting"). It is interesting partly because of Mother Nature, partly because this is truly a "Last Frontier" where man's control over his environment is less secure than in many other places, and partly because the students (people who live in this environment) are often survivor types and "different".

Lesson 2: Use Interactive Teaching Style

As is noted in [HILLS92], an interactive teaching style works best with this IDG technology. It is a challenge for the instructor to find ways to maintain that style and to avoid lapsing into the mode of lecturing into the void without feedback.

Lesson 3: Develop Suitable IDG-Related SOP's

Many IDG-related problems can be avoided or worked around with suitable Standard Operating Procedures (SOP's). At this writing, SOP's are still being invented. Two examples:

1. IDG sites should save desired screens to disk (if they aren't already there), and then make hard copy AFTER the conference is over if hard copy is desired or needed.
2. DG sites that inadvertently drop out of the conference should use a standard conference re-enter procedure, such as: re-initialize the modem, re-boot the IDG PC, etc. This should be executed while maintaining as low a profile as possible.

Lesson 4: Maintain Multiple Alternative Communications Paths

Distance education depends absolutely on communications, and the richer the set of available communications methods the better. In both CS 101 offerings many alternative communications means were used to good effect. They are listed below in order of perceived value, together with typical uses:

Email: to make schedule changes, instructions for and receive lab assignments, make announcements, take and answer student questions, give exams and receive exams answers.

Fax: to do most of the above in the backup mode (note that the UACN IDG platform essentially includes on-line instructor help, because it includes audio conferencing).

Mail: for sending of bulk information such as books, software, and copies of Computerworld.

Discussion

Besides helping to deliver computer literacy education to the Bush of Interior Alaska, this ongoing IDG technology evaluation has highlighted some distributed system theoretical issues and surfaced some technology performance and cost issues. It has also inspired some research in the UAF Department of Mathematical Sciences Computer Science Program. These matters are discussed next.

Distributed System Theoretical Issues

From a theoretical point of view an operating IDG network is a distributed system in the true sense of the phrase. It is a distributed system in which all processors run a copy of the same program. It is a distributed system in which files may be fully replicated for improved response times, or else partitioned. For network categorization purposes, it is a peer m=network in a star configuration. It implements a shared blackboard at any time (except for certain cases, such a time when an IDG platform is joining or leaving the network. At such a time all shared blackboards are frozen for a little while). The "shared blackboard" paradigm is reminiscent of the Blackboard Systems paradigm found in contemporary Expert Systems.

When a site joins a conference already in session, the blackboard contents of the new site are a subset of the blackboard contents of the sites already present. This can result in some strange phenomena. For example, the new site might write on a part of the board which appears to be clear at the new site, but which is already in use for the "older'" sites. From a theoretical point of view, this phenomenon is related to the distributed system data base concurrence control problem.

There are many other interesting related theoretical issues and questions. For example, how many concurrently operating sites can reasonably be supported? Clearly the IDG data bridge must be a limiting factor because of the star network architecture. This architecture simplifies network synchronization, but the data bridge is a potential performance for large numbers of participating IDG's. This problem is reminiscent of the synchronization problems associated with massively parallel processor design, a topic of considerable current interest. Other interesting questions involve the probable impact of widely differing IDG processor speeds (e.g., 586's in some IDG platforms, and 286's in others). Many of these questions, unfortunately, will not be addressed in the present technology evaluation.

Platform Performance Improvements by Preloading

IDG platform response times can be improved by preloading slides from the lecture site to the other participating sites before each lecture (i.e., by deliberate file replication). This procedure involves increased communications costs, because the preloading requires additional telephone connect time. For the UACN IDG network, the preload of 12 slides typically takes about 15 minutes, depending on the particular choice of slides. The performance improvements resulting from such preloads are thought to be significant, but the exact performance improvements resulting haven't yet been carefully measured.

Platform Performance Improvements by Defragmentation

As is the case for performance of most PC-based systems, the performance of the IDG platform is limited by the performance of its disk. A newer model IDG might get significantly improved performance from a faster disk, or perhaps from a disk cache. The improvements that might result haven't yet been calculated.

Given the current IDG platforms, it seems likely that IDG performance can be substantially improved by disk defragmentation, especially after an IDG platform has been in use for some time. The benefits of this action will probably be explored in the next few months. If the defragmentation action proves to be quite beneficial, then it could be made a part of a standard IDG platform periodic maintenance procedure.

Acquisition and Operational Cost Issues

As was noted elsewhere in this paper, a typical IDG platform costs about $15k without the TV camera, and about $25k if a TV camera is included. Communications costs, for both data and audio conferencing, are about $22/hour per IDG platform.

The use of a multiplexor might cut these communications costs in half, but the IDG platform performance impact of this step hasn't been fully evaluated. Also, there is a reliability advantage in having two separate phone lines for each IDG platform instead of just one. Administrators have expressed to me their concerns about the IDG-related communications costs. It seems that some of these concerns might be mainly due to university budgeting anomalies.

Inspiration for Research

The operational use of the IDG platform at UAF's Chapman Hall, in the middle of the Computer Science program area, has had a stimulating effect on the Computer Science program research efforts. So far there have been two related research projects. One project, done by Greg Moore, entailed the design and test of a novel data compression algorithm to speed IDG data transfers [MOORE92]. The other project was done by Lakshmanan Sankaran. He developed a software package called SAME (for Symmetric Application Mirror Enhancement). It required the design, implementation and test of an IDG-like network implemented via Xwindows and Unix on a number of RISC workstations that were interconnected by a high speed local area network [SANKARAN93].

Summary and Conclusions

The UACN IDG technology was evaluated by using it for the distance delivery of two computer literacy courses in Interior Alaska in 1992. Some IDG problems were discovered, and they have been discussed. However, on the whole the IDG technology performed well in this application and both courses were well received by their students. The IDG platforms are relatively inexpensive, very reliable, inexpensive to operate and easy to use. Some possible areas for IDG platform improvements were mentioned, but none of them have yet been explored at UAF.

The IDG technology and its related network have proved to be an interesting area from a distributed systems theory point of view. Two UAF Master of Science in Computer Science research projects that are directly related to this area have been completed so far.

The preliminary conclusions are that the networked IDG platforms worked well for CS 101 for both single remote site and multiple concurrent remote site cases. Effective use of the IDG technology requires the development of a number of SOP's, many of which may have to be invented by the instructor. It also seems to require the use of an interactive teaching style.

The prospects for the continued use of this IDG technology or derivatives thereof in Interior Alaska distance education applications appear to be good.

Acknowledgments

I'm pleased to acknowledge the major contribution of Greg Moore, former Manager of the Alaska Telegraphics Project, to the success of this IDG evaluation project. He showed me methods for its effective use. In addition, he helped me with other matters such as the appropriate handling of difficult cross-cultural education issues. I owe a special debt to Alex Hills, because the IDG network I used would never have existed without his courage and vision in selecting, acquiring, and installing it (Alex was the Director of the University of Alaska Computer Network (UACN) until recently). He also provided for continuing UACN support of the IDG network during the three site offering in Fall '92. That support was essential to the success of the multi-site offering. The support was provided specifically by Earl Voorhis, "the man at the bridge", who monitored every multi-site session and who also took field trips to correct problems at remote sites when necessary. Barry Willis, presently Director of Statewide Distance Education in the University of Alaska System, helped me by providing comments on this paper and by providing distance education insights and perspectives. Finally, my anonymous reviewers have helped me to improve the paper significantly.

References

[ALASKA90] "The Alaska Almanac -1990 edition", Alaska Northwest Books, Anchorage AK, 1990.

[CHUGACH90] "Communications Issues of the '90s", Proceedings of the Chugach Conference, 5-6 October 90, UAA Center for Information Technology, 2221 East Northern Lights Boulevard, Suite 209, Anchorage AK 99508.

[CHUGACH91] "Finding Our Way in the Communication Age", Proceedings of the Chugach Conference, 3-5 October 91, UAA Center for Information Technology, 2221 East Northern Lights Boulevard, Suite 209, Anchorage AK 99508.

[GISLASON93] Private communications between Knoke and Gislason re. results of remote delivery of Math 107 via IDG to Tanana.

[HILLS92] "Using Interactive Digital Graphics in Education", Alex Hills and Greg Moore, Business Communications Review, April 1992.

[IISTECH91] "GTCS User Guide (2nd ed)", IIS Technologies Inc (a Bell Canada Company), March 1991. Address of IIS Technologies is: 275 Matheson Blvd., East Mississauga, Ontario, Canada L4Z1X8

[JESSUP93] "Group Support Systems: New Perspectives", Leonard M. Jessup and Joseph S. Valacich, Macmillan Publishing Co., New York, 1993

[KNOKE93] "TeleTeaching with IDG in Interior Alaska", Peter J. Knoke, Proceedings of TeleTeaching 93, Trondheim, Norway, 20-25 Aug 93.

[KNOKE92] "Distance Delivery of CS 101 via Interactive Digital Graphics", Peter J. Knoke, UAF Department of Mathematical Sciences Report, 28 Aug 92.

[MOORE92] "A New File Compression Algorithm for Interactive Digital Graphics", Greg Moore, Project Report for MS in Computer Science, Department of Mathematical Sciences, University of Alaska Fairbanks, 23 Nov 92 (draft copy).

[MOORE87] "An Electronic Chaulkboard System: The Installation and Initial Operation of an Interactive Audio/Visual Communications System", Greg Moore, Chukchi Community College Report, January 1987.

[OHLER91] "On-Line Communication & Distance Education", Jason Ohler, University of Alaska Southeast, 11120 Glacier Highway, Juneau, Alaska 99801, 1991

[SANKARAN93] "Symmetric Application Mirror Enhancement", Lakshmanan Sankaran, MS Computer Science Project Report, Department of Mathematical Sciences, University of Alaska Fairbanks, May 1993.

[THOMAS92] "History of Educational Telecommunications in Alaska: An Application of the Diffusion of Innovations Theory", Natalie Thomas, 1992, Boston University School of Education, Doctoral Dissertation (available from University Microfilms).

[WILLIS92A] Written Email comments by Barry Willis regarding draft versions of evolving Knoke IDG papers.

[WILLIS92B] "Effective Distance Education: A Primer for Faculty and Administrators", Barry Willis, University of Alaska Statewide, May 1992.

Paper (T1.8a)
Technological Advances Reflected in a Current Elementary Instructional Reading Approach

Mary Coesfeld Huneke
Ladue School District
Chesterfield, Missouri

Abstract

A discussion is offered of a school's transition from a traditional basal reading instruction program to a combined approach in which whole language characteristics were blended into a current basal program. Technology played a roll in blending whole language traits into the basal program. The use of computers was extended from the computer lab and incorporated into the centers' organization of the classroom, thereby allowing teachers to more readily integrate the reading and writing program.

A description of how the program evolved, the concerns that drove and shaped the delivery of instruction, and the program evaluation process reflect practitioners responding and involving themselves in current research and technological advances within the elementary school setting.

Introduction

Technological advances have enhanced the way reading and writing are taught in American schools; and Spoede Elementary School is just one example. We can regress to the not too distant past to understand why this statement can be made today.

Since the publication in 1967 of Chall's *Learning to Read: the Great Debate*, the amount of phonics taught in the United States has increased (Carbo, 1988). Historically, reading was a clearly defined set of skills, taught with the help of the basal reader (Varnon, 1990). Underlying the basal reading series available in the United States today is the assumption that learning to read is a skill-by-skill and word-by-word process, and is commonly referred to as a skills-centered or a code-emphasis approach. This part-to-whole approach to the teaching of reading is based on principles of behavioral psychology and scientific management developed a half century ago and treats meaning as merely an end to be attained after words are identified and sounded out, by breaking them up into bits and pieces.

Basal readers, commercially designed, several-hundred-page long textbooks and their accompanying workbooks, worksheets, and other paraphernalia, dominate reading instruction in the United States (Harman, 1991). They are the most universally available materials for reading instruction. The basal program consists of a series of basal readers; one or more basal readers are provided for each grade level (Wood, 1984). Lessons involve: reading and discussion, skills instruction, and skills assessment. The lessons are usually combined into three or four units, and at the end of each unit is a review test designed to assess mastery of the skills taught therein (Wood, 1984). If a student passes the unit test, the student moves up in the sequence to the next unit, or the next higher reading group. This produces homogeneous grouping of students according to ability, and is a common aspect of the basal approach to the instruction of reading. If the student does not pass, the teacher can provide additional practice on the skills missed, and later retest to determine if mastery was achieved.

Presently opinion is divided about the best way to teach reading. More recent research by Goodman and Smith, and others, helped lay the foundation for the whole language instructional approach (Harp 1991, Goodman 1991). Goodman and Smith indicated that reading is a whole-to-part process of constructing meaning rather than merely obtaining meaning. Consequently the emphasis is shifting from a skills approach, with its concentration on word identification, to a psycholinguistic, comprehension-centered or meaning-emphasis approach that stresses *overall* meaning and comprehension (Loucks-Horsley, 1988). The whole language reading approach is replacing reliance on the basal reader-dominated pattern of the past.

The controversy on the best way to teach reading has divided researchers into two camps—the phonics camp, with Chall as its proponent, and the whole language camp. The discourse between the camps has produced the extremist's dichotomy, code-emphasis versus meaning-emphasis. This debate over whether an emphasis on the code or on meaning works best in teaching reading may have provoked other researchers to express that the matter does not inevitably devolve into an either/or dichotomy. Their comments to educators indicate that we need not choose between one or the other approach; that combining the two can be efficacious (Hillerich 1990, Taylor 1989).

At Spoede School, we stand the middle ground previously described. We are reluctant to abandon phonics and old tried and true methods in favor of new, yet unproven ones. Instead, we have opted to try new techniques in the context of familiar structures. We have established a blended program, in which we have merged several whole language characteristics into our traditional basal program. For example, some whole language traits which have been assimilated are:

1. Emphasis is placed on the students' own writing with invented spelling. Having computers in the classroom has helped us bring the writing dimension from the computer lab and allowed us to integrate writing into the reading program. Word processing (*LogoWriter* across all grade levels with *Bank Street Writer III* at fourth and fifth grades for word processing) at the computer allows for editing to take place later after the initial thoughts have been roughly sketched. The computer helps students get their ideas committed quickly on the screen and worry about editing later. Hence, the child's own oral language production is used as a bridge to written language. Spoken language is acquired in the context of ordinary everyday interaction. Research shows that children learn language as a way of fulfilling real needs and performing real communicative acts (Goodman, 1986). An objective of the whole language practitioner, therefore, is for the child to experience written language as equally natural and functional. Classroom instruction involves drawing parallels between spoken and written language, and the child comes to realize that print represents the same language s/he has been speaking and hearing for years. Writing, like reading, is changing from a product orientation in which grammar, spelling, handwriting, and neatness have held paramount importance, to a process approach that makes meaning of primary focus for the writer (Loucks-Horsley, 1988). Our computers have become a tool to help the practitioner teach children that written language is as natural and functional as spoken language.
2. Literature sets have been incorporated, which promote *literature* and student ownership of tradebooks.
3. The whole language concept is based on the premise that *language arts are integrated activities*. Speaking, listening, writing, and reading are interrelated and interdependent (Stahl & Miller, 1989). Strong parallels are believed to exist between learning oral language and learning to be literate (Harp, 1991). Written language is best learned the same way spoken language is acquired—in context.

Instruction invites the student to recognize oral language in the printed text. Since evidence shows that reading and writing are interactive, interdependent experiences (Hillerich, 1990), whole language instruction encourages the student to write about what has been read, thereby improving comprehension, reinforcing vocabulary, and confirming the attitude that communication (rather than the mechanical processing of words on paper) is the goal of the student's effort.

Subsequent to integrating the language arts curriculum our teachers have started working on integrating science and social studies curricula into the centers to help our students transfer learning from one discipline to another as they establish meaningful connections between separate academic strands. Some brief examples to illustrate teacher integrations are: 1.) the students read about Miss Rumphius who makes a place beautiful with flowers; at the computer center the pupils were directed to draw a flower and label its scientific parts. 2.) In the Watery World reading unit activities at a center brought in the ecosystem from a science strand. 3.) For the Remember When reading unit famous Americans were linked to a center from the social studies unit. Like other teachers, we saw that cross-curricular connections could solve some of the management problems that have occurred as a result of the proliferation of curriculum, materials, and State and District objectives.

Historical Perspective

The initial success, of *Writing to Read*, a computer-based reading and writing instruction program, influenced the establishment of our program, which we later titled Integrated Curricula Language Centers (I.C.L.C.). *Writing to Read*, beginning at kindergarten and implemented in first grade as well, was introduced at Spoede Elementary School during the 1986-1987 school year. A writing lab was established to house the technological I.B.M. equipment needed to operate the program and to provide a stimulating writing environment for students. The writing that was conducted was experience-based and adhered to the various phases of writing used throughout all grades: 1.) pre-writing, 2.) writing, 3.) individual conference with the teacher in regard to the writing, 4.) final draft, and 5.) oral reading.

Positive indications of formative evaluation showed support for the program. The integrated technique and use of technology to meet the needs of our students received strong support from faculty, parents, and enthusiastic students. An assessment of the program revealed favorable reading and writing results. The Gates-MacGinitie Reading Test was administered to first grade students as part of the school's regular fall assessment program. Additional spring test scores were collected to follow student progress. The results confirmed that the reading growth of the students was greater than the average growth expected during the time frame. Since monitoring the growth of student writing had been a Ladue District interest, an independent researcher was made available to take a writing sample to evaluate elementary student writing. The group of Spoede students evidenced significant maturity in their compositions. The use of vocabulary, sentence structure, and writing mechanics was beyond grade level expectation. The evidence suggested that this type of integrated program could be extended to second and third grades, and provided the impetus that shaped the present delivery of instruction.

The first staff-development undertaking was to provide, second and third grade teachers and specialists, release time to observe classrooms in other schools where teachers were experimenting with technologically integrated programs. Simultaneously they explored and evaluated current basal programs. Basal publishers have themselves responded to the new needs and the new research, and they have incorporated several whole language components. Varnon (1990) stated that many of the recent series include well-known, respected literary selections and reflect a modern approach to skills instruction. Manuals from these updated programs focus on building experiential background, teaching children to set purpose for reading and to make predictions, and building writing into the reading curriculum. (Varnon, 1990, p.2) At that point in time, as a faculty we agreed that what was then on the market would not suit our particular needs. Consequently, the teacher-initiated I.C.L.C. program, based on the recently selected basal, was written during the summer of 1989 and was implemented that fall at the second and third grade levels. ,

Integrated Curricula Learning Centers is a classroom management system based on a learning centers approach. The concept of centers learning is that pupils complete specific tasks at various locations in the classroom. Centers were used to reinforce the learning that took place for the entire class in the formal reading group. After the class was dismissed from formal reading instruction they moved in groups from center to center while the teacher conducted small group instruction. Hence, I.C.L.C. allows children to work independently on tasks that are related to the lesson while the teacher conducts small group instruction. The eight integrated centers were: computer, spelling, handwriting, experience background, skills, writing, listening/browsing, and reinforcement. An example of what a child might be expected to do at a center may be a hands-on activity, at the spelling center, of using Scrabble pieces to make a crossword puzzle from their spelling words. The spelling words were selected from the story the children were reading.

The centers reflected advances in 1.) technology and 2.) educational research. In technology the computer center, with a printer and five Apple computer stations per classroom, was networked to the computer lab to provide spelling, background information on the story, and word processing for writing. The computer center eliminated paper and pencil tasks and promoted the concept of independent, self-directed learners. The computer changed the nature of the writing task. It freed imagination and creativity by eliminating barriers to revision. It enhanced the completed product by allowing the writers to view the complete project before committing it to paper. The teachers felt better equipped to teach language arts from a global perspective.

In educational research the heterogeneous grouping of students promoted a positive learning climate. Of all the factors that appear to affect student learning one holding perhaps the greatest influence is the set of beliefs, values, and attitudes teachers and students hold about learning. Lawrence Lezotte and his colleagues defined learning climate as the norms, beliefs, and attitudes reflected in instructional patterns and behavior practices that enhance or impede student learning. The attitudes that students form about academic learning come, in part, from the adults in the school. In studies of effective schools it is clear that the norms for learning come from the staff's requirements of students.

The heterogeneous grouping is based on the belief that nearly all students can learn at their age and grade levels. Benjamin Bloom holds that almost all students are capable of achieving age- as well as grade-level objectives. James Block and Lorin Anderson made this the basis of their program of Learning for Mastery. They propose making objectives attainable for students by returning to objectives until they are mastered. This belief to succeed is incorporated in I.C.L.C., which does not stratify students according to ability, which inevitably become levels of expectations. Integrated Curricula Learning Centers sets the tone for high expectations. In addition to establishing a positive learning climate, having our classrooms heterogeneously organized has allowed our teachers to implement other pedagogical practices such as cooperative learning groups.

The reinforcement center was used by students identified by the classroom teacher as requiring remedial work; and it was maintained by the teacher offering these students special services. It worked in place of pullout remedial reading, with the special services teacher rotating among the classrooms, or concomitant with a pullout remedial program. It is viewed as less stigmatizing to those students who have been identified as weak in a particular area.

What About Results?

A program evaluation was conducted to evaluate the effectiveness of the approach to the teaching and learning aspects of language arts. Our concern for student success, as well as concern for the financial magnitude of purchasing hardware, networking capabilities, and providing stipend for teachers who wrote the program called for monitoring our endeavors. The field study was started when the program was implemented, in the fall of 1989, for the purpose of determining whether the school would retreat from the program, maintain the current level of engagement or extend the effort as appropriate. It was projected to be a longitudinal study so that the progress of the students could be monitored over time. At that juncture the scope of the study encompassed five second and third grade classrooms with a teacher assigned to each class.

The program evaluation consisted of classroom teachers' assessment, parent and student survey responses, as well as qualitative and quantitative assessments. The qualitative assessment consisted of pre- and post-classroom observations conducted by five central office administrators. It showed that the program exerted much in the way of positive influence on student skills and behaviors through the qualitative evaluation procedure used. The quantitative assessment examined the second and third grade students to determine if they were growing in reading at the expected one year (9/9) rate of growth prior to experimental intervention. After the determination that this was the case, fall (September 1989) and spring (March 1990) grade equivalent scores were collected. It was expected that from fall to spring the growth would be 6/9, as it is six months from September 1989 to March 1990. Students would grow in reading the equivalent of six months which is 2/3 of one year's growth (6/9 = 2/3 = .67).

Results showed that average reading growth for the second grade class during the six month period was one year (9 months) plus two months, or 1.2 school years. Therefore, the class' average reading growth of eleven months exceeded the expected six months growth by five months, or 83%. Analysis of data resulting from fall to spring testing indicated that second grade was making significantly ($p < .005$) greater progress in reading achievement than normal. The probability of getting a t-value this large by chance alone was less than 5 in 1,000.

Average reading growth for the third grade was nine months, which exceeded the expected growth of six months by 50%. Analysis of data resulting from fall to spring testing indicated that the third grade was showing significantly ($p < .01$) greater progress in reading achievement than expected. The probability of getting a t-value this large by chance alone was less than 1 in 100.

With such positive results the program was extended to subsequent grade levels in which the focus of the assessment was quantitative.

Which Ability Group Was Accountable For Such Growth?

Our interest was in determining if high ability readers achieved at the same rate as middle ability or low ability readers. The administrators wanted to know if our high ability readers were making the gains in achievement while possibly our poorer readers remained stagnant. Consequently, future assessment focused in this area, and continues to be monitored to this date.

There was some concern that in using this new program that we would lose the children who teachers worry about the most—those at risk, those at the bottom of the class. There was also some sentiment to the contrary expressed in the belief that the students who excel would tutor, mentor, or pull others along. Parents of high achievers were worried that their children could be held back by slower students. When we taught to the whole class, we intended to teach at grade level with high expectations, and provide a rich centers curriculum in which higher order thinking skills could be incorporated. Generally, our longitudinal assessment showed that our low ability groups grew at about the same rate as the high and middle ability groups (Huneke, 1992). We discovered that our bottom group responded favorably to the fact that they were included and not stigmatized. It was felt that the centers was one aspect that helped these students succeed along-side the others. For example, at the listening center the teacher could provide a tape of the basal story and allow students to hear it and follow along. At the reinforcement center children do not carry the stigma of being pulled out; they are included with everyone else.

Conclusion

The steps taken by the practitioners in this particular school represents just one example of how teachers think about and practice their art. It represents a true professionalism in which teachers have established their own operational theory. They have responded to the new technological tools and scientific research, and have enacted it in the classroom for their pupils' benefit.

References

Carbo, M. (1988). Debunking the great phonics myth. *Phi Delta Kappan, 70* (3), 226-40.

Goodman, K. S. (1986). *What's whole in whole language?* Portsmouth, NH: Heinemann.

Goodman, Y. M. (1989). Roots of the whole language movement. *The Elementary School Journal, 90*, (2), 113-27.

Harman, S. (1991, November). Commentary: The basal 'conspiracy'. *Education Week*, pp. 32.

Harp, B. (Ed.). (1991). *Assessment and evaluation in whole Language programs.* Norwood, MA: Christopher-Gordon.

Hillerich, R. I. (1990). Whole language - whole truth. *Teaching Pre-K-8, 20*, 23-7.

Huneke, M. C. (1992). A longitudinal assessment of elementary students who participated in a basal program with a whole language approach to reading instruction. Ph.D. St. Louis University.

Loucks-Horsley, S. (1988). The reading-writing connection: A whole language approach. An Annotated Resource List. Linking R&D to Practice Series No. 9603. Andover. (ED296308)

Stahl, S. A. & Miller P. D. (1989). Whole language and language experience approaches for beginning reading: A quantitative research synthesis. *Review of Educational Research, 59* (1), 87- 116.

Varnon, D. (1990, November). *Streamlined Seminar: Easing into whole language.* (Available from National Association of Elementary School Principals, 9 (2), Alexandria, VA)

Wood, K. D. (1984). Read first, test later: Meeting the needs of the overskilled reader. *Reading Horizons, 24*, 133-40.

Paper (T1.8b)
Forming High School and University Alliances: Magical Things Can Happen

Carol W. Wilson
Western Kentucky University
Bowling Green, Kentucky

Abstract

This paper is a success story about an alliance of high school and university computer science teachers that was established at Western Kentucky University. It also provides a "How To Guide" to forming teacher alliances. There is a nationwide movement to build alliances between public schools, higher education, and the business community. By working together to solve common problems, they all become stronger. In April of 1988, a CS Teachers' Alliance was formed by CS teachers from 16 school districts who were attending the annual high school programming contest at Western Kentucky University. High school and university faculty joined together to share with their peers; solve common problems; and develop professionally. This paper will explore the background of the alliance movement, how to form an alliance, and some of the activities and accomplishments of the Kentucky Computer Science Teachers' Alliance.

Background

Professional organizations exist for the mutual benefit and education of their members. Because a group is much stronger than an individual, the popularity of alliances has grown. Alliances vary in size from local alliances such as the Professional Development Center Network based at Western Kentucky University (A consortium of 26 school districts that pool their resources to provide quality inservice training) to large national organizations such as the Triangle Coalition for Science and Technology Education. An extremely good description of an academic alliance is found in "Local Physics Alliances", a leaflet published by the American Physical Society.

What is an alliance? An alliance is a group of school and college instructors who meet every month or two to share their physics knowledge and the challenges of teaching physics. Like their professional colleagues in medicine or law, they meet to update their knowledge and to share responsibility for the practice of their profession locally. Together they decide their agenda and then seek the physics knowledge, program development, and public support needed to accomplish their goals. Often they engage local business and industry in their efforts, as well as school and university officials.

A local physics alliance keeps teachers current with physics and with research, methodology, and educational technology, so their students are better prepared for work and future study. School science teachers, who shape young peoples' early and lasting attitudes toward science, gain wider access to resources and improved professional standing and confidence. College faculty with an understanding of the working conditions of their school colleagues, can aid in preparing and recruiting students whom often they will teach a few years later. Both school and college faculty benefit by sharing their knowledge of teaching strategies and research in physics learning. By sharing their goals they are able to work together to gain community support for high quality science education.

If you and your colleagues want to strengthen physics teaching in your community, gain greater visibility, and increase support for your profession, starting an alliance will help.

The steps required to form an alliance are: identify a need and an interested group of people, establish a steering committee to plan activities and projects, and then invite additional people to join the alliance.

In 1988 the Kentucky Council on Higher Education was awarded an Eisenhower grant to establish math/science alliances in the state. Each of the regional universities was commissioned to foster such alliances in their service area. Western Kentucky University helped form alliances of high school and university teachers of chemistry, physics, geology/geography, and computer science.

The vehicle for organizing the CS alliance was the annual high school programming contest sponsored by the Computer Science department. Two years earlier, I had implemented a concurrent professional development workshop for the teachers to give them something meaningful to do while their students were competing. The expanded activities of an alliance were a logical outgrowth of these workshops. A high school computer science teacher in rural Kentucky is isolated from other computer science teachers because he/she is usually the only CS teacher in the county. The need to share ideas with their peers and to keep up with changing curriculum was so great that the alliance spread throughout Kentucky and into northern Tennessee. This April the alliance meeting was attended by representatives from Evansville, Indiana who hope to duplicate our efforts in Indiana.

My Role as Alliance Coordinator

I am a facilitator who:

1. makes the resources of the University available to the alliance. These include meeting space, secretarial help, phone, and the academic expertise of the university faculty.
2. works closely with the alliance steering committee to determine and address the needs of the members.
3. works closely with the Kentucky Department of Education and the College of Education to provide the membership with information and services.
4. serves as a clearing house for information about endorsement requirements and computer science education curriculum. I receive one or two requests a week for information from inservice and preservice teachers.
5. coordinates the CS faculty speaker's bureau which provides speakers to area high schools. I also distribute copies of the ACM "Careers in Computers" kit.
6. edits the annual newsletter, which is mailed to every high school computer science teacher in Kentucky. Communication is the key to binding together a statewide organization. It is critical that the classroom teacher receives accurate information about new developments on the state and national level. The newsletter has provided information on the following:
   a. Endorsement to Teach Computer Science—When Kentucky implemented a CS endorsement the new guidelines were published, as well as the forms that the school district needed to fill out so that a teacher could apply to be "grandfathered".
   b. New Kentucky Course of Study in Computer Education
   c. State Textbook Adoption List
   d. Course Outline for the Introductory Programming Course
   e. Proposed ACM Model High School Computer Science Curriculum
   f. The newsletter also contains articles of general interest, registration material for the Kentucky Educational Technology Conference, information about upcoming programs, and sources of free or low cost teaching aids.
7. serves as a problem solver. Example: This year I had been working with a teacher to implement an AP Pascal course at her high school. I had provided her with the names and phone numbers of two master teachers who have AP classes and she enrolled in a data structures course to improve her Pascal skills. At the April programming contest, I inquired about what textbook she had selected for the course. Due to budget problems there would be no money for new textbooks for her class. But she did have two different Pascal books that her class of 9 could share!!! At the University we had just changed to a new edition of our CS1 text so I put out a call for help to the faculty. Within an hour, we were able to scrounge up 10 desk copies of our previous textbook, a teacher's manual, transparency masters, and the test bank. As the teacher left, loaded down with books, her parting words to me were "Carol, I love you."

Activities

Generally two workshops are scheduled each year. One takes place during the annual programming contest and the second is a day long summer workshop. The content of the workshops is determined by responses to a questionnaire that is included in the newsletter.

Often the workshop provides enrichment on a computer science topic. University faculty and master teachers are glad to share their expertise. Example: When we explored "Artificial Intelligence and Robotics" there were four presenters. One CS faculty member gave an overview of artificial intelligence while another spoke about his experience in helping to write the AI programs that control the Space Shuttle engines. A faculty member from the Industrial Engineering department demonstrated some simple robots and showed a film strip about the history of robotics. And a high school teacher detailed the unit on robotics that she does with her classes, complete with lesson plans and where to obtain the materials.

Other workshops provide information about curriculum guidelines or new regulations. Example: Because this has been a year of curriculum change, at the April workshop we discussed ACM Curriculum 91, that impacts higher education, and the proposed ACM Model High School Computer Science Curriculum.

Activities with statewide impact

The alliance was able to have a significant impact on computer education in Kentucky by working with Michael Bidwell, who was Instructional Computing Consultant, Kentucky Department of Education.

1. Course of Study in Computer Education—A workshop, entitled "H.S Computer Curriculum: What Should We be Teaching", was held in conjunction with the annual programming contest in April 1989. Sixteen teachers reviewed the draft of the Kentucky "Course of Study in Computer Education" and their written suggestions were forwarded to Michael Bidwell. Our input resulted in significant changes to the final version of the "Course of Study".
2. Course Outline for Computer Programming 2120—Kentucky had no course outline for the first year of H.S. programming and the course description was vague. The teachers who attended the summer workshop in August 1989 wrote a course outline for Computer Programming 2120. Michael Bidwell was very impressed by our work, and invited me and Joyce Leonard, one of the master teachers, to present the course outline to the state CS

teachers at the Kentucky Education and Technology Conference on Feb. 27, 1990.

3. Statewide Textbook Adoption—Michael Bidwell appointed committees of classroom CS teachers to review and select the new textbooks, Summer 1990. This was a major breakthrough because "classroom teachers" finally had a voice in choosing the textbooks they will be using.

Budget

It requires very little money to operate the alliance. The major expenses are :

- Newsletter—duplication and postage
- Refreshments for meetings
- Speakers (variable expense)

For the first four years Eisenhower funds were available and my yearly budget was $500. Most of the expense was in paying presenters at the summer workshop. This year my budget is $0, and the work continues. The newsletter was financed by the Dean's office in the College of Education, the CS department provided the refreshments, and the presenters were unpaid (most faculty members graciously give their time as public service).

Summary

The most important product of the alliance formation is the increased communications between area computer science teachers. Instead of being an isolated CS teacher, often the only one in the county, he/she is now part of a network. They have called upon one another to solve problems, share ideas, and even borrow equipment in an emergency. As a group they have explored new topics in computer science and had a voice in computer education at the state level.

Paper (T1.8c)

What Makes Teachers Use Computers?

Edward Vockell
Purdue University Calumet
Hammond, IN

Helen Jancich
Crown Point School System
Crown Point, IN

Jackie Sweeney
Portage Adult Education Center
Portage, IN

Paper not available at press time

Paper (T1.9a)

Microcomputer-Based Laboratories for Non-Majors' Physics Courses

Doug Davis, Steven W. Daniels , Charles E. Miller and Rachelle Bergmann
Eastern Illinois University
Charleston, Illinois

Abstract

Using a grant from the National Science Foundation, we have established a Microcomputer-Based Laboratory for Non-Majors' Physics Courses. This laboratory uses student workstations consisting of a Macintosh IIsi computer and interface hardware and software applications from Vernier Software. This laboratory allows immediate data acquisition and immediate construction of graphs. Student and faculty reception of this new laboratory has been enthusiastic.

Non-Majors' Introductory Laboratory

In the fall of 1991 the Physics Department of Eastern Illinois University was awarded a grant through the Instrumentation and Laboratory Improvement (ILI) program of the National Science Foundation (NSF) to develop a Microcomputer-Based Laboratory (MBL) for Non-Majors' Physics Courses. Previous experience with a similar project for the majors' courses had clearly shown that the amount of time and effort necessary for good software development is beyond our capabilities. It was decided that commercially-available software/hardware packages would be used. Much work on computer interfacing for introductory Physics laboratories has been done in recent years by Priscilla Laws[1] of Dickinson College, Ron Thornton of Tufts University, and David Sokolov of the University of Oregon. The results of their efforts—the hardware interfaces and the software applications—are now available from Vernier Software[2].

It was decided to use the entire package of interface hardware and software available through Vernier Software. The computers for this endeavor are Macintosh IIsi's with 40 MB hard drives and 11 MB RAM. Along with Vernier Software's data acquisition hardware and software we use *Graphical Analysis* (Vernier's simple graphics program) for data analysis and *ClarisWorks* as a word processor and spreadsheet.

In the spring semester of 1992 we began using these materials in our algebra-based, *Principles of Physics* course (a typical "pre-Med Physics" course). We have implemented seven new[3] laboratories (Introduction to *ClarisWorks, Graphical Analysis,* Motion with the "sonic ranger", Spring Constants and Energy, Simple Harmonic Motion, Sound, and Fourier Transforms of Voice); we have converted three previously existing experiments into forms that will use this new technology (Newton's Second Law (F=ma), Motion on an Inclined Plane, and Momentum Conservation), and students have used the data analysis and word-processing capabilities of these computers for all of the laboratories. In addition, the MBL has been used for several demonstrations and laboratories in our course for Speech-Pathology majors, *Physics of Sound and Music*. It has also been very popular as part of our open house demonstrations with visiting high school and junior high students.

It is worthwhile to describe a few of these experiments. The MacMotion lab uses the sonic range finder from a Polaroid camera. Under computer control, a transducer emits a short burst of ultra-high frequency sound and then listens for the return of its echo. By timing the echo, the computer calculates the position of an object. Graphs are immediately constructed showing position, velocity, and acceleration as functions of time. The distinction between velocity and acceleration is very important in Physics but it is a subtlety that causes many students great difficulty. The immediacy of the constructed graphs increases student understanding. Furthermore, in this experiment students make graphs of their own motion so it is easy to recall the differences between "how did I walk to make a constant velocity graph?" and "how did I walk to make a constant acceleration graph?" This is an example of an experiment that is heavily based upon *Tools for Scientific Thinking* from Tufts University and available from Vernier Software. It is also an example of a lab that really can not be done without the computer.

Our new Momentum Conservation experiment is the same in principle as our old, pre-computer experiment. Two gliders collide on a frictionless air track and their speeds before and after the collision are determined by measuring the time that flags mounted on the gliders interrupt the light in a photogate. Previously students were hard pressed to make five or six runs in a two-hour lab due to the time required for them to carry out the calculations. If the results were "strange" or unexpected there was seldom time to make another run. Now, with data acquisition and data analysis using the computers, it is easy to produce numbers and compare momentum and kinetic energy before and after the collision. Now students can concentrate on why momentum or kinetic energy is not as fully conserved as the textbook and professor always imply. Now there is time to make a few more runs and see if the "strange" data is reproducible. There seems to be more learning going on and not as much grinding to just get something done before time runs out.

Our *Physics of Sound and Music* course has used the MBL equipment as a (limited) storage oscilloscope and for Fourier analysis of waveforms. These experiments begin by looking at the simple waveforms from the flute voice of a low-cost electronic keyboard[4] and continue with more complex waveforms like a piano or clarinet and finally look at the human voice of the student. Being able to look at one's own voice, of course, adds interest to the lab.

In the fall semester of 1992 use of the MBL will be extended to our *Adventures in Physics* survey course. Following (somewhat) the advice and example of Professor Laws at Dickinson College, one section experimented by changing format from three hours of lecture and two hours of lab to one hour of lecture and *four* hours of lab. That format is continuing on an experimental basis. There is a trade-off here for less Physics material is covered but it seems that students are understanding principles more.

Use of the MBL in our *Physics of Sound and Music* course is expected to expand. By spring semester of 1993 we expect use of the MBL to be extended to the second semester of our *Principles of Physics* course (the "pre-Med Physics" course)[5]. The MBL is also being used in the fall of 1992 for a Special Topics course for majors on *Mathematica*.

Some of our experiences with the MBL are far more general than Physics. We spend the first lab period learning *ClarisWorks* and students write a paragraph or two about themselves, make an "illustration" and enter a few numbers in a spreadsheet. It may be worth extending this to two periods. We have learned that it is necessary to spend time teaching the basics of Macintosh computers as a foundation for the entire sequence of labs which follow. Even a Mac is not as intuitive at first as it seems to a seasoned user. Once this is done, though, the students consistently choose to work with the computers when given the choice of doing things by hand or by computer.

Evaluation by students indicate that they enjoy the labs and feel they are understanding the Physics better than without the computers. We are aware of and concerned with what might be termed "black box syndrome". Are students really *learning* better or just enjoying the course better? Anecdotal data suggests they are, indeed, learning better. Faculty are happy with the results. We have three computers–two Mac's and an IBM P/S 2–on carts which can be moved into lectures and used with an overhead projector. Those are being used more and more often by faculty.

Our experiences suggest that prepackaged hardware interfaces and software applications are ideal for our educational situation. Faculty find it interesting and time-efficient to produce the lab write-ups and students at all levels find the programs usable and helpful. We have not followed the exact format of *Workshop Physics* or *Tools for Scientific Thinking* but we have managed to introduce this new technology into our Physics curriculum quite successfully. Reports from both students and faculty indicate that learning is enhanced and that general excitement levels are higher. The computer hardware interfaces and software applications have been and will continue to be a great asset to our curriculum.

References

[1] Priscilla Laws, *Calculus-Based Physics Without Lectures, Physics Today*, v 44, December 1991, pages 24-31. Priscilla Laws, *Worksho Physics—Learning Introductory Physics by Doing It, Change*, v 23, nr 4, July 1, 1991, page 20.

The work of Priscilla Laws is known as *Workshop Physics;* that of Ron Thornton and David Sokolov is known as *Tools for Scientific Thinking.*

[2] Vernier Software, 2920 SW 89 St, Portland OR 97225, 503-297-5317. Other interfaces are also available. PASCO Scientific, for instance, has several interface devices for Apple II computers and IBM PC's and compatibles.

[3] These labs are "new" to us but some of them draw heavily upon material from Vernier Software which is based upon *Workshop Physics* or *Tools for Scientific Thinking.*

[4] A Casio SK-1 keyboard is used.

[5] The in-person presentation in Orlando will describe the experiences gained with the expansion of use of the MBL in the 1992-93 academic year.

Paper (T1.9b)
Image Processing on a Personal Computer

Richard Johnsonbaugh and Steve Jost
DePaul University
Chicago, Illinois

Dicran Goulian III
Hollister Inc.
Libertyville, Illinois

Abstract

Although many excellent image processing systems exist, many of them are expensive and require special hardware. In this paper, we present DPUIMG, an easy-to-use image processing program that runs on widely available IBM and IBM-compatible systems. The program is menu-driven and does not *require Microsoft Windows, a mouse, extended memory, or a display with resolution higher than VGA. DPUIMG has been used at DePaul University in pattern recognition and image processing classes and could be used in other classes such as algorithms and data structures classes to illustrate applications to image processing. DPUIMG accepts 8-bit images up to 640 by 480 pixels and provides the following functions which allow the user to interactively process the image and quickly see the results: display an image; display part of an image; produce a histogram of gray levels in an image; smooth an image; find edges; compute the Laplacian of an image; threshold an image; and add, subtract, multiply, or divide all gray levels in an image by a constant. After processing the image by selecting one of the functions, the system provides the option of writing the processed image to a file for analysis or further processing. A utility is also provided that translates an image to a postscript file, which can then be printed on any postscript printer. The source and executable files are available at no cost from the authors.*

Introduction

A *digital image* is a two-dimensional array of numbers, each of which gives the brightness at that point of the image. These brightness values are called *gray levels* and the elements of the array are called *pixels* (picture elements). Typically a low gray level indicates dark and a high gray level indicates bright. A digital image can be manipulated by performing various operations on the gray levels of its pixels. For example, the image can be smoothed (blurred) to reduce noise or the edges of objects in the image can be highlighted. As another example, each pixel having a gray level above a certain level, called a *threshold*, can have its gray level set to the brightest possible level, and each pixel having a gray level below the threshold can have its gray level set to the darkest possible level. The purpose of thresholding an image is to locate objects in the image. For example, if the objects appear light on a dark background, an appropriate threshold can define the objects. (Figure 1 shows an image of coins on a dark background, and Figure 2 is the thresholded version of Figure 1.) References on image processing are [1,4].

Image processing systems have been available for some time for sophisticated computer systems. An example is the public domain program *Image* [3], available from the National Technical Information Service, which requires a well-equipped Macintosh (two to eight megabytes of memory and an 8-bit video card with the ability to display 256 colors or shades of gray). On the other hand, because of their power, low cost, and widespread availability, IBM and IBM-compatible personal computers (PCs) are widely used by students to aid them in their study of computer science; but, until recently PCs have not played a large educational role in image processing because the power, capacity, and cost of a PC configured to fulfill this role put it out of reach of many students. The image processing system DPUIMG provides the software to do useful image processing on commonly available PCs.

DPUIMG aids students in understanding basic image processing concepts by allowing them to load an image and view it on a PC equipped with VGA (or better) video resolution. DPUIMG can be used to display an 8-bit image or subimage of up to 640 by 480 pixels in 16 gray levels. DPUIMG also provides several image processing functions which allow the user to interactively process an image and quickly see the results. Among the functions provided are: produce a histogram of gray levels in the image; smooth the image; compute the Laplacian of the image; find the edges of the image; threshold the image; and add, subtract, multiply, or divide all gray levels in the image by a constant.

System Requirements

DPUIMG runs on any IBM PC or compatible equipped with a VGA display. A hard disk is recommended. The Borland C graphics file *EGAVGA.BGI* is required. Although DPUIMG will run with less than 640K of RAM, it is best to run it with at least 640K of RAM. All images are internally converted to 16 bits requiring twice the storage of the original 8-bit image. Also, image operations require a temporary buffer the same size as the image. In general, if the input image is of size *n*, the amount of available RAM should be approximately 4*n*.

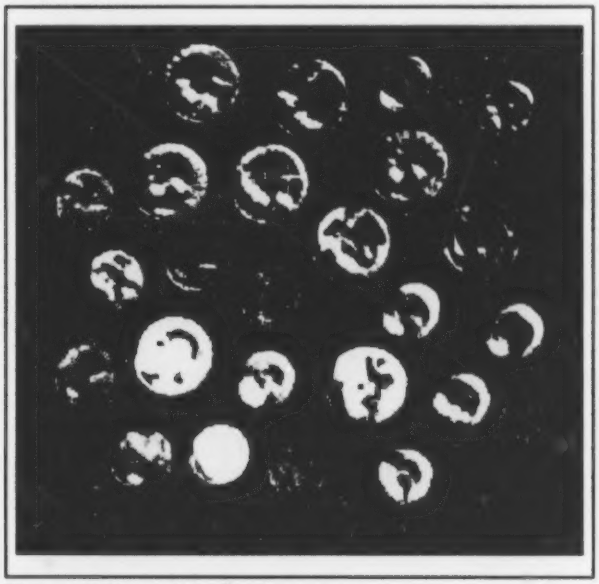


Figure 1. The original coins image.

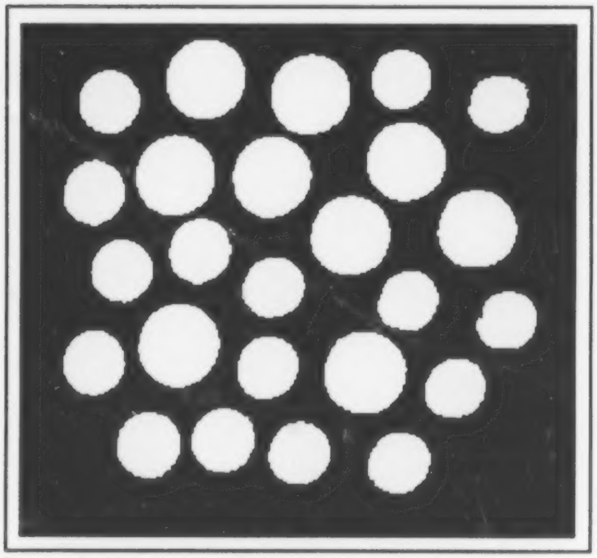


Figure 2. The thresholded coins image

There are two main reasons for maintaining an internal 16-bit format. First, working with a 16-bit image allows the processed image to exceed the internal 255-bit limit without overflow or data loss, as for example when the image is multiplied by a constant. After multiplication by a constant, the image may appear saturated, but a simple division by the same constant will restore the image. Second, adding support for external 16-bit images will be easier if the program already handles 16-bit images internally.

The source and executable files are available at no cost from the authors. The code, written in C, was constructed so that it would be easy to add features or to modify the code.

Running DPUIMG

Before loading an image, DPUIMG requires some information about the size of the image and the portion of the image to view. The image must be raw data; that is, the file must contain no data other than the image data in 8-bit pixel format. In particular, there must be no header in the file. (A possible enhancement would allow images in standard formats such as TIFF and PICT to be loaded.) DPUIMG can load a subrectangle of the image. This is useful if there is not enough RAM to load the entire image, or if you do not wish to process the entire image.

The program prompts the user for:

- File name
- Image width and height (in pixels)
- Window width and height (in pixels)
- *x*- and *y*-coordinates of the upper-left corner of the window

The program stores the last parameters used in a file and offers them as the default values the next time the program is run. Pressing *Return* selects the defaults; otherwise, new values, which become the new default parameters, must be entered.

Once the prompts have been answered, the program loads the image in the upper-left corner of the screen and displays the menu choices at the top of the screen (see Figure 3).

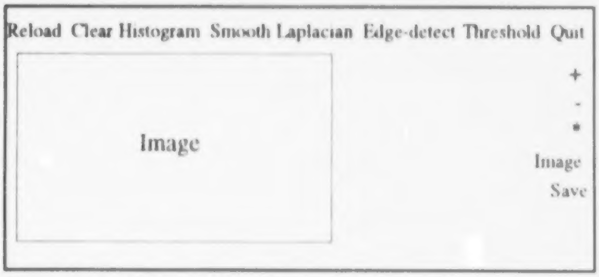

Reload Clear Histogram Smooth Laplacian Edge-detect Threshold Quit
Image
+
-
*
Image
Save

Figure 3. The DPUIMG screen.

The "Reload" option allows you to reload the original image on the screen. This is useful if the user wants to process the original image more than one time. All processing functions are applied to the image that resides in the main image buffer. To save memory space, the original image is not kept in memory.

The "Histogram" option plots a histogram of the gray levels of the image on the screen and writes the data to a file, which can be printed or further analyzed. The histogram of the

BEST COPY AVAILABLE

coins image (Figure 1) is shown in Figure 4. A histogram is sometimes useful for determining a threshold value. In Figure 4, we see two hills. The leftmost hill, which consists of gray levels having low values, comprises primarily the background. The rightmost hill, which consists of higher values, comprises primarily the coins. We see from the histogram that the coin gray levels are more spread out than the background gray levels. This is due to the fact that the dark background has less variation than the brighter coins. A threshold that corresponds to a value between the two hills will separate the coins from the background (as shown in Figure 2).

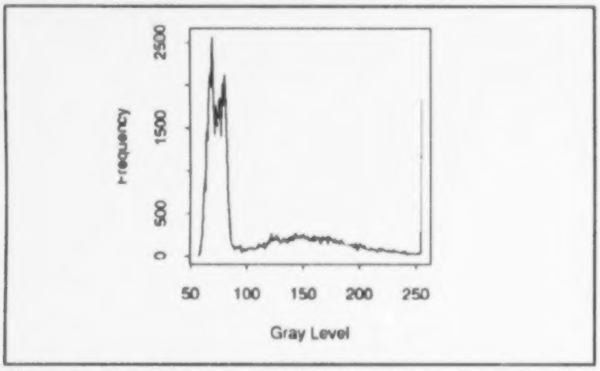


Figure 4. The histogram of the coins image.

The "Clear" option clears the image from the display but leaves the menu on the screen. This is useful for clearing the screen after the "Histogram" option has been selected since the histogram is usually written over the displayed image.

The "Smooth" option smooths the image by replacing each gray level with a weighted average of it and the gray levels of the eight pixels nearest it. More precisely, the gray level of pixel i,j is replaced by

$$1/16(g(i-1,j-1) + 2g(i,j-1) + g(i+1,j-1) + 2g(i+1,j) + g(i+1,j+1) + 2g(i,j+1) + g(i-1,j+1) + 2g(i-1,j) + 4g(i,j))$$

where g_{ij} denotes the gray level of pixel *i,j*. Figure 5 shows the result of smoothing the coins image (Figure 1).

The "Laplacian" option applies what is known in the image processing literature as a Laplacian filter. It can be used to detect bright spots in an image. The gray level of pixel i,*j* is replaced by

$$-(g(i-1,j-1) + g(i,j-1) + g(i+1,j-1) + g(i-1,j) + g(1+1,j) + g(i-1,j+1) + g(i,j+1) + g(i+1,j+1)) + 8g(i,j).$$

Figure 6 shows the result of applying the Laplacian filter to the coins image (Figure 1).

The "Edge-detect" option applies what is known in the image processing literature as Sobel's edge filter. First, the value

$$-g(i-1,j-1) + g(i+1,j-1) - 2g(i-1,j) + 2g(i+1,j) - g(i-1,j+1) + g(i+1,j+1)$$

is calculated for each pixel i,*j*. Then, the value

$$-g(i-1,j-1) - 2g(i,j-1) - g(i+1,j-1) + g(i-1,j+1) + 2g(i,j+1) + g(i+1,j+1)$$

is calculated for each pixel *i,j*. Finally, the gray level of pixel *i,j* is replaced by the sum of the absolute values of these quantities. Figure 7 shows the result of applying Sobel's edge filter to the coins image (Figure 1).

The "Threshold" option creates a binary image based on a user-supplied threshold. All pixels less than or equal to the threshold are set to zero, and all pixels greater than the

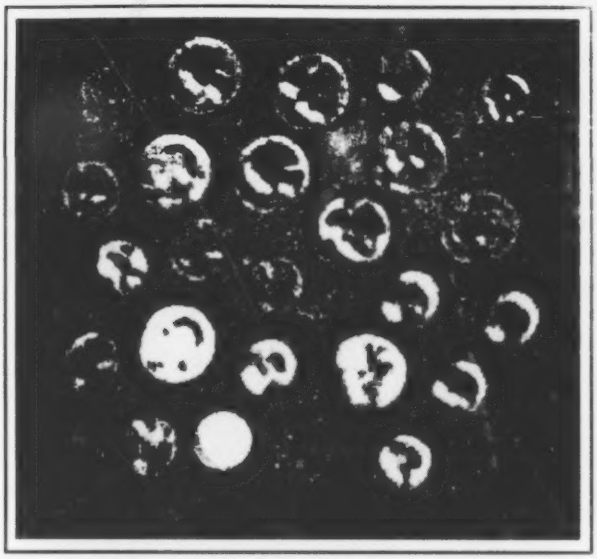


Figure 5. The coins image smoothed.

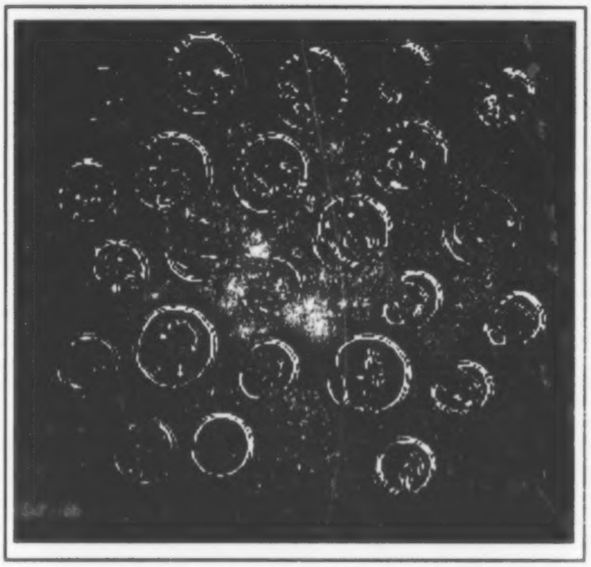


Figure 6. The result of applying the Laplacian filter to the coins image.

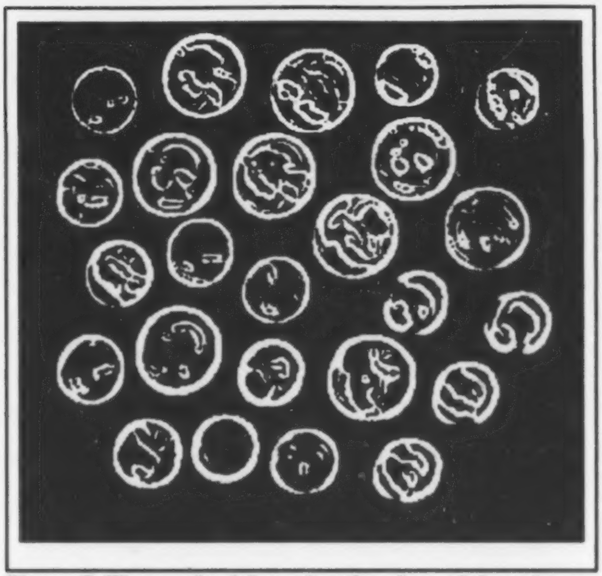


Figure 7. The result of detecting the edges of the coins image.

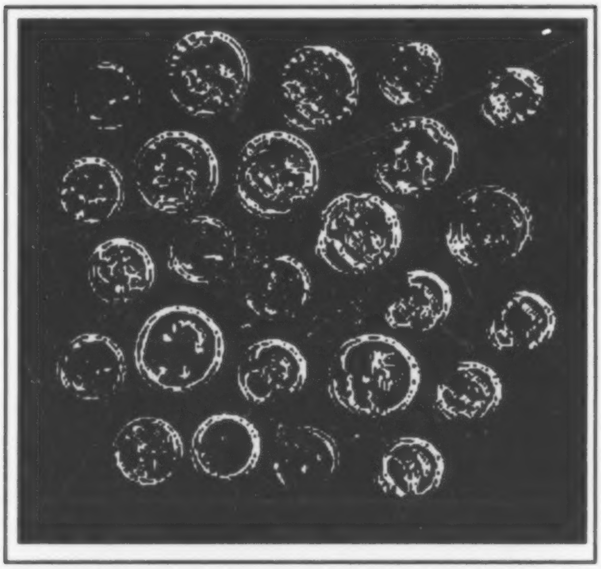


Figure 8. The result of multiplying the gray level of each pixel in Figure 6 by 2.

threshold are set to 255.

Selecting one of the "+", "-", "*", and "/" options prompts the user for a value which will then be added to, subtracted from, multiplied by, or divided into the gray level of each pixel. Figure 8 shows the result of multiplying the gray level of each pixel in Figure 6 by 2.

Selecting the "Image Save" option prompts the user for a file name. DPUIMG then writes the currently displayed image to this file.

Selecting the "Quit" option causes the program to terminate.

The standalone utility makep*ost* is also furnished as part of the DPUIMG system. This utility takes as input a raw image (the same kind of input that the main program takes) and produces as output a file containing a postscript version of the image. The output file can then be printed on any postscript printer. The *makepost* utility is invoked with parameters to specify the names of the input and output files as well as the size of the input image.

Conclusions

DPUIMG has been used in the pattern recognition class at DePaul. Pattern recognition (see, e.g., [2]) is concerned primarily with the automatic classification of objects. Although the source of the objects to identify is not restricted to images, frequently the problem is to identify objects in images. The emphasis in our course is on pattern recognition, but enough image processing is covered so that students can manipulate images and extract features from images to use in analyzing the images. It is essential that these students be able to see the result of various operations on images so that they can easily determine whether the operations result in the desired and expected behavior. A software package that allows students to manipulate images and explore image processing fundamentals does not exist for commonly available PCs. The time and effort required for a student to develop software for this purpose could not be justified as part of our quarter-long pattern recognition course. With the help of DPUIMG, students can spend more time learning classification techniques and less time developing image processing code necessary to obtain data.

References

Dougherty, E. R., and C. R. Giardina, Image *Processing*, Prentice Hall, Englewood Cliffs, N.J., 1987.

Fukunaga, K., Int*roduction to Statistical Pattern Recognition*, 2nd ed., Academic Press, New York, 1990.

Image, available via anonymous FTP from alw.nih.gov in the directory /pub/image.

Jain, A. K., Fu*ndamentals of Digital Image Processing*, Prentice Hall, Englewood Cliffs, N.J., 1989.

BEST COPY AVAILABLE

Paper (T1.9c)
Computers-in-Education in Malaysia: The Way Ahead

Zoraini Wati Abas
University of Malaya
Kuala Lumpur, Malaysia

Abstract

Malaysia's efforts in introducing computer literacy and Computer-Assisted Instruction into secondary schools are described in the paper. It first introduced a Computer Literacy Pilot Project in 1986 but this was put on hold after a year when it was found unsuitable. Following a period of reassessment and replanning of the use of computers in schools, the Ministry of Education relaunched a computer literacy project in 60 rural schools throughout the nation and established a research and development project to develop a Computer-Integrated Learning System, that is, Sistem ComIL. Sistem ComIL comprises an authoring system, a database applications system and a network applications system. When fully developed, it can develop and deliver CAI courseware as well as manage learning and enhance communication within and outside the country. Although the country has tried to overcome the inadequacies associated with the first failed project, problems still emerge. These problems are also highlighted.

The impact of computers on education has not only been felt in developed countries but in developing countries as well. Malaysia in particular has organized several forms of computer literacy activities for its secondary schools. This ranges from computer clubs, camps, competitions and the teaching of a computer literacy subject. The country, whose population is 18 million people and whose total secondary school population is approximately 1.42 million, is today not only focussing on computer literacy but also looking at the use of computers for instruction, that is, Computer-Assisted Instruction (CAI).

The Progress of Computers-in-Education in Malaysia

Malaysia's efforts in inculcating computer literacy skills among school children started in the early eighties when the Prime Minister of Malaysia urged schools to establish computer clubs ("Dr. Mahathir," 1983). The number of computer clubs has grown steadily in the last decade. There was, however, a big jump in the number of computer clubs formed between 1985 and 1986 (see Table 1). This jump occurred amidst intense interest and widespread publicity on computer literacy in schools (Zoraini, 1988, 1989). Today, more than 800 schools, that is, over half of the secondary schools in the country, have computer clubs. Club activities focus on learning to use popular software packages such as Printshop, Wordstar, dBase and Lotus 1-2-3 as well as BASIC programming.

In April 1986, the Ministry of Education launched a Computer Literacy Pilot Project (CLPP) in twenty selected secondary schools throughout the country. Each of these schools received five microcomputers, a printer, software and had two of their teachers specially trained to teach a computer literacy subject to fourth year students. However, the project was discontinued a year later when it was found to duplicate computer club activities ("Warning," 1987). Furthermore, the ministry then could not afford to allocate an estimated US $50 million to supply computers to every secondary school in the country ("Why low priority," 1987).

It can be said that planning was haphazard, resources were scarce, funding was hardly available, and officials who managed the project were not very familiar with the use or implementation of computers in education. At best, the officials were only two steps ahead in their computer knowledge as compared to the average educator. Making things more complicated was the fact that the development of computers in education in the rest of the world, especially in the developed countries, was very rapid.

It was realized that the situation had to be rectified because the country needs a computer literate populace. This is in order to achieve what is popularly known to Malaysians as Vision 2020—to be a fully developed country by the year 2020. Thus steps to ensure success in implementing computers in education must be well planned and carefully carried out.

To arrest what seemed as haphazard efforts in bringing computers to schools, a joint committee between the Ministry of Education (MOE) and the Malaysian Institute of Microelectronic Systems (MIMOS) was formed in December 1986. It's main tasks were to study the needs, problems, requirements and suggest ways to overcome problems and how computers could be effectively implemented in schools.

In January 1989, this joint committee presented a proposal to the Minister of Education, suggesting among other things, that there be:

- a national policy on application of computers in education
- an integrated plan for computerization
- a national educational computer network
- a national educational database system
- a new division for computers in education in the Ministry of Education

- use of information technology across the curriculum for teaching and learning in all primary and secondary schools (Tengku Mohd Azzman, 1991a).

Year	*Number of Computer Clubs*
1981	1
1984	70
1985	167
1986	478
1988	500
1990	800

Table 1. Computer Clubs in Malaysian Secondary Schools*

Following the submission of the proposal to the Minister of Education, two important projects have been initiated and launched by the ministry. Firstly, MIMOS received funds to carry out a joint research and development project with the Ministry of Education. The project was primarily to develop a software which could be used to deliver and manage instruction more effectively than via traditional methods.

The main objective of the research and development project was to develop a software called Sistem ComIL (Computer-Integrated Learning System). Sistem ComIL consists of three components: an authoring system, a database applications system and a network applications system. In other words, Sistem ComIL could be used to develop and deliver CAI courseware as well as manage learning and enhance communication within and outside the country. This project is discussed more in a later part of the paper.

Secondly, a computer literacy project was re-introduced to first and second year secondary school students. This project was launched by the Minister of Education in July 1992. Sixty pilot schools were chosen for the project. These are located in the rural areas, with some schools accessible only by boat. Rural schools were selected so as to provide a more equal distribution of computers and exposure especially because most urban schools have computer clubs.

Each of the 60 schools received 20 Atom-1 computers (IBM PC/XT compatible) and a 386-SX based server. Said to be tough, affordable and easy to maintain, the Atom-1 computers was specially designed for Malaysian schools. It is a balance between technology, educational needs and financial capability (Tengku Mohd Azzman, 1991b).

Each of the schools also received Word Perfect 5.1, dBase IV, Draw Perfect 1.1, Lotus 1-2-3 Release 2.3, D-Link's LANsmart and EJA-BM Teks (a Malay language word processor with a spelling checker). Learning to use these software is part of the computer literacy syllabus. An evaluation of this project is being carried out to detect difficulties and problems prior to implementing the project beyond 60 pilot schools. The major plan is to equip computers and teach the computer literacy subject in all secondary schools by 1995.

To manage the computer literacy project, a Computers-in-Education Unit (CIE Unit) was set up with five officers. The unit selected the 60 pilot schools, provided in-service teacher training to two teachers from each school, selected the software for schools and ensured the supply of Atom-1 computers to the schools.

These two projects support one of the major aims of the Sixth Malaysia Plan, which is, to implement projects for computers in education. The country aims to lay a strong foundation for a computer literate society as well as to create a culture oriented towards knowledge and information (Malaysian Government, 1991).

It is even more important now that the government has identified Information Technology (IT) as one of the key technology areas for building competence and developing niche areas for domestic industries. This is in line with Malaysia's aim to encourage more technologically sophisticated industries be set up in the country ("Govt identifies IT," September 24, 1992).

It thus appears that introducing the computer in schools and getting the computer to be part of the daily experience at an early age is most advantageous and almost necessary. The research and development project and the computer literacy project were very timely.

The Development of Sistem ComIL

The Sistem ComIL project started in August 1989 with a budget of US$2 million. The project is expected to be completed by 1994 or 1995, that is, by the end of the Sixth Malaysia Plan. So far, most of the time has been spent on developing the authoring system. The beta version authoring system was launched by the Minister of Education on August 8, 1991. It has been distributed to all 60 pilot schools. At the launch, the minister suggested that a Courseware Development Centre be set up to boost the implementation of CAI in Malaysian schools.

Many people are involved in Sistem ComIL's development. These include six educational consultants who conducted a needs analysis before preparing and submitting the design specifications. The design specifications were then translated into technical specifications by four computer software development consultants. All ten consultants were lecturers from various local universities.

A Computer Technology Laboratory under the joint supervision of the Ministry of Education and MIMOS was set up for the purpose of the Sistem ComIL project. Eighty computer programmers and engineers were employed to develop Sistem ComIL. Unfortunately, because the positions of those employed were only temporary, benefits offered were too few. As a result staff turnover has been very high. Many of the more talented programmers and engineers have left the project for secure jobs. This has unfortunately slowed down the project.

Nevertheless, the vacancies are continually being filled but not quickly enough due to the presently high market demand for qualified computer personnel.

Ten teachers from schools throughout the country were seconded to the project to help in the formative evaluation of Sistem ComIL. Their primary responsibilities are to develop sample courseware to ensure that Sistem ComIL is easy to use and that necessary features are included. From time to time, Sistem ComIL is demonstrated to the public and the teachers not only demonstrate but collect and assess the feedbacks received.

Rationale

Many have raised questions concerning the importance of developing an authoring system when many similar authoring tools are available in the market. Some of the authoring tools available in the country and which are familiar or have been used to a limited extent include Private Tutor, Linkway, Authorware Professional and Hypercard.

Some do not understand why the ministry is spending US$2 million to develop its own authoring tool which will take five years to complete. It could have very easily selected any of the available authoring tools and begun to develop the necessary courseware for schools.

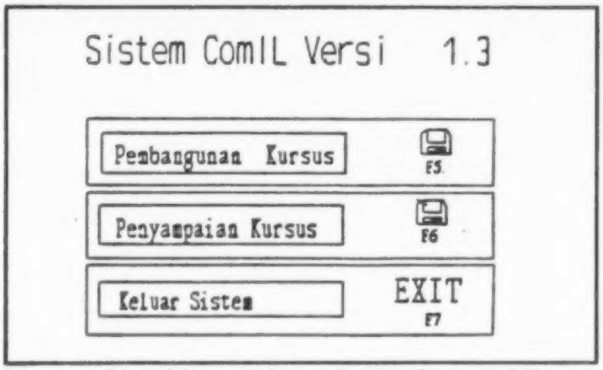


Figure 1. Main Menu of the Authoring System of Sistem ComIL

There are strong arguments to this. Clearly, the country has much to gain when it develops its own authoring tool. Firstly, the local authoring tool hopes to be able to meet most pedagogical requirements not found in most existing authoring tools. Secondly, in the process of developing the tool, the country would have enhanced the experience and skills of its local, young and talented professionals. Thirdly, it contributes to the growth of the local software industry and lastly, it would contribute to the economy by not having to channel the funds overseas for any use of software developed outside the country.

Features of the Authoring System

System Requirements

The authoring system of Sistem ComIL can run on any IBM or IBM compatible with a minimum Random Access Memory (RAM) of 640KB. However a RAM of 1MB is recommended so that the courseware developer need not exit from the authoring mode to the delivery mode to test run his courseware. A hard disk space of at least 20MB is required and only one drive is necessary. It can run on either EGA or VGA mode. Input can be made via the keyboard, mouse or trackball. It is anticipated that other input devices will be added to the list in the future.

Characteristics

The authoring system is menu driven and has a series of pull down menus. The most unique feature of the authoring system is that it communicates to the user in the Malay language, the national language of Malaysia (see Figure 1). This makes it one of the very few software available in the country to operate in Malay.

The main menu consists of three options. These are (a) Courseware Development ("Pembangunan Kursus"), (b) Courseware Delivery ("Penyampaian Kursus") and (c) Exit to system ("Keluar Sistem"). To select an item on the menu, one either highlights the option with the mouse or trackball, or types a designated hotkey. The first two options are briefly described in the following section.

Courseware Development.

There are three options under courseware development (see Figure 2). The first is the interface manager which is where the author would create his courseware. The various functions available in the interface manager is shown in Figure 3. The second and third options are the graphic and audio editors, respectively. The graphic editor enables one to create, import or edit graphics. In create graphics mode, boxes, circles and ellipses, multiple lines, polygons, curved lines, bitmap and grids are available. The audio editor on the other hand, is where one can create, input or edit sound.

Courseware Delivery.

This sub-menu is where one would request a particular courseware to be loaded and run. The list will be based on the courseware titles available in the current logged drive and/or sub-directory.

Users

Users have been limited to two major groups. The first group consists of the ten teachers seconded to the R & D project, whose main task is to help evaluate the authoring system. The second group consists of teachers from the 60 pilot schools around the country who were trained to use Sistem ComIL over one week. Several of these teachers are attempting to create their own CAI courseware in schools.

Ease of Use

Based on observations and users' feedbacks, Sistem ComIL is easy to use, has attractive color and graphics and comparable to other established authoring systems. According to the coordinator of the R & D project, Sistem ComIL has been well-received by the public based on comments received during exhibitions. Sivarani (1992) noted that the authoring system of Sistem ComIL is simple to learn and easy to use. A person with limited computer experience should be able to learn the system in two days.

Evaluation and Feedback

Based on a research conducted by Sivarani (1992), Sistem ComIL holds much promise. In her study, she evaluated Sistem ComIL (beta version 1.3) against a set of universal standards for an authoring system. She found that Sistem ComIL is comparable to other advanced authoring systems in terms of hardware configurations and software characteristics; screen design and appearance; text creation capabilities; graphic, animation and editing capabilities; and sound creation capabilities. However, features which are very useful for courseware developers are lacking. These include:

- a text editor with word processing functions
- an in-built command to do animation
- a test editor which (i) enables questions to be typed in easily, (ii) has answer processing, and (iii) has feedback capabilities
- ability to record voice from an external source
- administrative capabilities such as (i) storage of student's data, (ii) storage of student's performance and progress record, (iii) ability to analyze answers statistically, and
- proper documentation and embedded training in the use of the various features.

It should be noted however that a test editor, features to manage student data, student performance and progress have been planned and will be available in the final version. The documentation is also being improved. Other features which Sistem ComIL still lacks will also be incorporated as a result of the evaluation.

Conclusion

It is too early to claim that Malaysia will be successful in its implementation of computer literacy and CAI projects in its secondary schools. Perhaps results will be clear in four or five years time.

However, during its current stage of implementation, it is facing several problems. Firstly, the CIE Unit is too small to manage a national level project. Secondly, the positions of the software developers at the Computer Technology Laboratory are only temporary and there is a high turnover of staff and this has affected the development of Sistem ComIL. Thirdly, courseware to be used with Sistem ComIL was expected to be available and its absence has created doubts over the capability of Sistem ComIL as a serious authoring system. Some of these problems are not unlike those encountered in any other similar project.

It is suggested that as part of the evaluation of the ministry's projects, that several research studies be conducted to ascertain the problems and success attained so far. These include studies of the attitudes of the 120 teachers from the pilot schools, the attitudes of the students toward the use of computers, the problems encountered by the teachers and students, the management of the computer laboratories in schools, the suitability of the distributed software packages, and others.

Malaysia has gone through two phases of implementation of computers in education. Its first pilot project in 1986 was short lived. Fortunately, the country was able to reexamine the priorities, restudied the problems, reassess the needs, proposed better plans and attempt to try again to make computers in education work for the benefit of the country. Interestingly, a locally-designed computer and a local authoring system were seen as two of the essential components for success. A more conclusive study needs to be conducted in the next few years. What can be said so far is that Malaysia is on the path towards having a more computer literate populace.

References

Dr. Mahathir syor tubuh kelab komputer di sekolah [Dr. Mahathir calls for the establishment of computer clubs in schools.] (1983, October 5). *Berita Harian*, p. 1.

Govt. identifies IT (September 24, 1992). *Computimes*, p. 1.

Malaysian Government (1991).*Sixth Malaysia plan (1991-1995)*. KL: National Printing Department.

Programme to boost computer literacy (1985, October 1). *Computers*, pp. 1-2.

Sivarani Rajadurai (1992). *An evaluation of the authoring system of Sistem ComIL (Computer-Integrated Learning System)*. Unpublished master's thesis, University of Malaya, Kuala Lumpur.

Tengku Mohd Azzman Shariffadeen (1991a, May). *Scenarios for computer use in education*. Paper presented at the Malaysian Council for Computers-in-Education 5th Anniversary Celebration, Petaling Jaya, Selangor Darul Ehsan.

(1991b, September 12). The case for CIE. *In.Tech*, p. 1 & 9.

Vital Statistics: Facts and figures of the IT industry (1991, August 12), *Computimes*, p. 1.

Warning to schools (1987, April 30). *Computimes*, p. 1.

Why low priority for computer courses (1987, September 10). *Computimes*, p. 1.

Zoraini Wati Abas (1988). The progress of computer literacy in Malaysian secondary schools. In Peter Alp (Ed.), *Golden Opportunities: Sixth Australian Computers in Education Conference Proceedings* (p. 17-31). Mount Lawley, WA: Educational Computing Association of Western Australia.

(1989). Moving towards the computer age: The Malaysian experience. In Wong, Zaiton, Bing Selamat & Ainun (Eds.), *18th Annual Conference of the International Association of School Librarianship Conference Proceedings* (pp. 347-369). Kalamazoo, MI: IASL Secretariat.

*Source: Ministry of Education, "Programme to Boost" & "Vital Statistics"

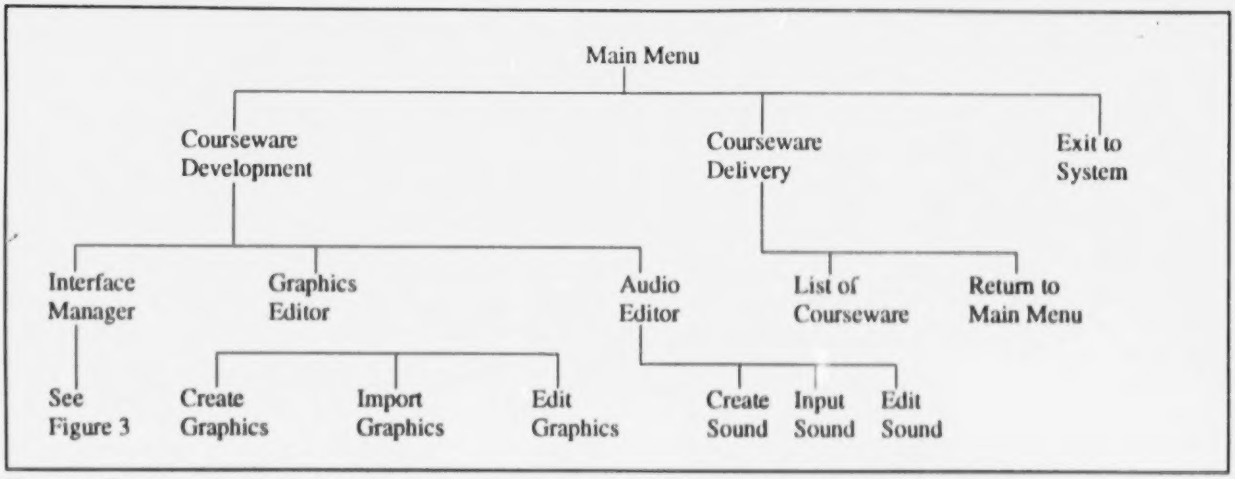

Main Menu
Courseware Development
Courseware Delivery
Exit to System
Interface Manager
Graphics Editor
Audio Editor
List of Courseware
Return to Main Menu
See Figure 3
Create Graphics
Import Graphics
Edit Graphics
Create Sound
Input Sound
Edit Sound

Figure 2. Functions available for Courseware Development in the Sistem ComIL Authoring System

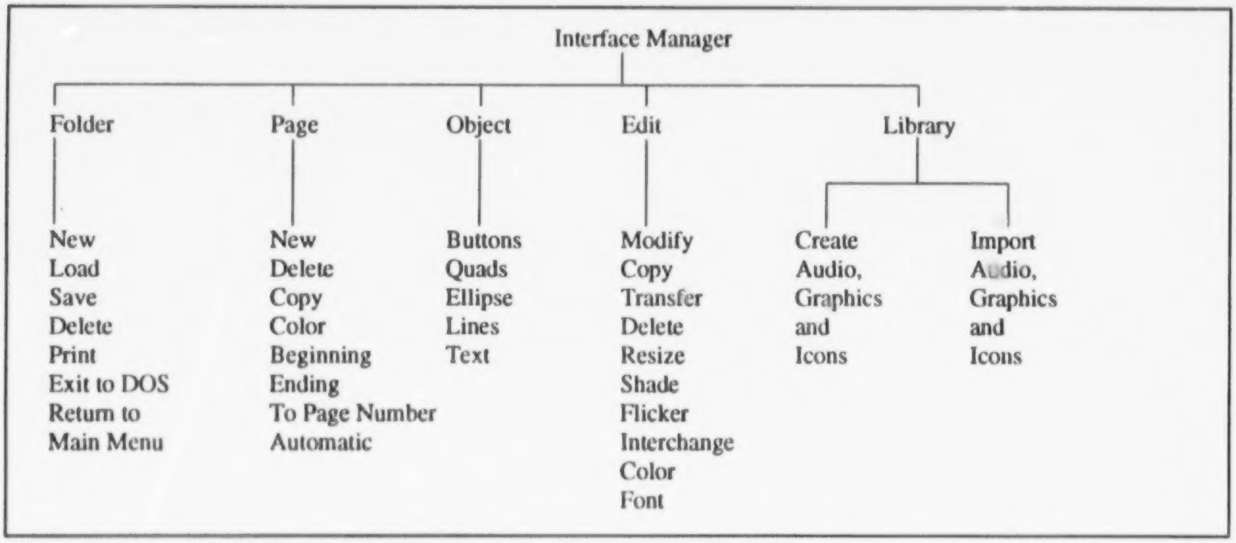

Interface Manager
Folder
Page
Object
Edit
Library
New
Load
Save
Delete
Print
Exit to DOS
Return to Main Menu
New
Delete
Copy
Color
Beginning
Ending
To Page Number
Automatic
Buttons
Quads
Ellipse
Lines
Text
Modify
Copy
Transfer
Delete
Resize
Shade
Flicker
Interchange
Color
Font
Create Audio, Graphics and Icons
Import Audio, Graphics and Icons

Figure 3.Features available in the Interface Manager

Projects (T1.10)
Teacher Training

Educational Technology: A Significant Field Experience Component

Jacqueline Dillon
Harris-Stowe State College
St. Louis, MO

Abstract

The object of this presentation is to demonstrate how an introductory field experience course at a small teacher education college has been structured to systematically select school-based sites on the basis of program diversity and the use of contemporary educational technology. Each semester, approximately forty-five introductory field experience students have the opportunity to visit nine different schools and three community-based learning resources. Consequently, the students are exposed to more than 400 classrooms which represent a wide-range of technology related learning activities at the early childhood, elementary, and middle/junior high school levels. Exposure to the extensive use of technology in the selected schools has a positive impact on the teacher education candidates who become increasingly aware of the need to enroll in contemporary educational technology in order to keep pace with the innovative uses of technology in the "world of practice".

Training Teachers to Effectively Integrate Technology into Their Instructional Programs

Herbert Rieth, Matt Ebeling, and others
Vanderbilt University
Nashville, TN

Abstract

The purpose of the presentation is two-fold. The first purpose is to report findings from the Teacher-Based Education for Children with Handicaps (TECH) project, a teacher training project designed to train teachers of students with mild handicaps to effectively integrate technology into their instructional programs. The second purpose is for individual project teachers to present microcomputer and multi-media integration projects.

Presenters will discuss issues related to feasibility, applicability, and practical utility of their projects for the average classroom teacher.

LaserNet: Dissemination and Implementation within a School

Barbara Shelly and Suzanne Gilmour
Westhill School District
Syracuse, NY

Marilyn Trainor
Central New York Teaching Center
Syracuse, NY

Abstract

In seeking to accelerate the use of educational technology in K-12 schools in the Great Lakes Region, GTE, in 1992, initiated a Pioneering Partners Award program. This project is one of three in New York State to receive the award.

The presentation will address the dissemination issues and implementation plans that resulted from this award/grant. The Pioneering Partners Project at Westhill High School uses a team approach to expand and integrate the use of technology in math and science classrooms. The traditional roles of teachers and students will be changed as a result of an ongoing collaboration based on the use of active participation, cooperative learning and technology as a learning tool in the classroom. In this project, staff development is viewed as a long term investment that is ongoing, self monitored, and which fosters collaborative and reflective practice. The project proposes the following opportunities for participants:

- ongoing collaboration with other teachers who share a similar interest
- use of computer and Laservideo medium
- access to mentor(s) who foster a sense of confidence in trying new ideas
- support from administrators
- a sense of empowerment to seek outside resources for attending conferences and additional training if necessary

This project is a non-commercial venture; it is a GTE Pioneering Partners funded project for 1992-93.

The Development and Implementation of an Instructional Computing Program for Preservice Teachers

Ann Thompson, Denise Schmidt, and Neal Topp
Iowa State University
Ames, IA

Abstract

If future teachers will be expected to use technology effectively with students in classrooms, they must have adequate preparation and appropriate experiences throughout their preservice program. Over the past ten years, the College of Education at Iowa State University has developed and implemented an instructional computing program for preservice teachers that is designed to make technology an integral part of the teaching and learning environment. The program includes the following three components:

1. a course in computer-related technology
2. computer-related technology experiences in foundations, methods and field experience classes
3. an optional minor in educational computing that includes eighteen credits of coursework in computer-related technology topics.

Until faculty from colleges of education begin to model the use of computer-related technologies in their classes and provide opportunities and experiences for preservice teachers to use computer-related technologies throughout their teacher education program, little can be done to affect the future use of these technologies in schools. Although the technology program at Iowa State University is continually evolving, it is designed to empower students with the knowledge and attitudes necessary to use technology as a tool for their own teaching and learning.

Projects (T1.11)
Restructuring

Educational Technology Research and Development: The Texas Challenge

Ken Brumbaugh
Texas Center for Educational Technology
University of North Texas
Denton, TX

Paul Resta
Texas Center for Educational Technology
University of Texas at Austin
Austin, TX

Abstract

This session presentation and handouts will: 1) summarize Texas Center for Educational Technology (TCET) recent and active research and development projects in Texas, and 2) feature a TCET teacher training research project at the University of Texas at Austin. Informational materials for K-16 educators will be presented and distributed that focus on the practical results and information gained from TCET's first three years of operation as Texas' educational technology research and development center. The UT-Austin project involves collaboration among school districts, educational service centers, private companies, and TCET and is aimed at impacting teacher training and public school practices through the creation of knowledge-building communities using Computer-Supported Intentional Learning Environments (CSILE) networks. Barriers, problems, and successful strategies for using CSILE will be presented and discussed.

Adapting Computer Based Instruction to Learning Styles of LD Children

Cathrine Byrd
Dean Learning Center
Dallas, TX

Abstract

The computer can be an effective tool to provide Learning Different (LD) students with an alternative method for receiving information. Well designed computer software can provide one-on-one learning experiences with immediate, appropriate feedback and remediation when necessary. Dean Learning Center of Dallas is involved in an ongoing study with The Winston School, also of Dallas, to identify those software components which determine the success of an LD student utilizing a computer-based lesson.

The Winston School is a private school for average to above-average intelligence 1st-12th grade LD students. Since 1990, Dean Learning Center has provided the Winston School with a lower school computer class equipped with computer hardware, software, and an instructor. All lower school students at Winston attend this class each day for 45 minutes. The instructor documents student preferences and components which promote or hinder success with commercial software products.

Based on this information, Dean Learning Center has established a set of criteria for software design principles. This criteria is used to develop methods to supplement the software products within the classroom. The software design principles are incorporated in educational software products being developed by Dean Learning Center. Formal evaluations of commercial software products used in The Winston School computer classes are sent to the software developers.

Teachers Swap Textbooks For Multimedia

Fayette Clarke
Technology and Information Systems
Houston Independent School District
Houston, TX

Abstract

The presenter will summarize the Houston Independent School District's projects on textbook waivers. In may 1992, middle school teachers in art and social studies submitted textbook waivers to the Texas Education Agency. These teachers wanted to use technology solutions instead of the new textbooks that were up for adoption. The waivers were granted, and teachers were trained in July and August of 1992. In August 1992, the teachers began using multimedia equipment to teach seventh and eighth-grade art, and eighth-grade social studies.

The project report will discuss:

- waiver process
- hardware and software selection
- training
- on-going support and evaluation

This project is not sponsored by any commercial company.

This abstract was taken from the author's originally submitted proposal

Data Collection and Portfolio Development in a Restructured Curriculum

Chip Kimball
Madera Unified School District
Madera, CA

Abstract

Technology integration has proven essential in a restructured English/biology curriculum at Madera High School supported by Apple Computer. The focal point of instruction in this two-hour interdisciplinary course remains on project-orientation, research, and portfolio assessment. The use of computers for research, especially with original data collection in the field has been significant. Students develop customized databases for their data collection and later evaluate the data to determine its significance. Secondly, students use technology for their culminating presentation at the end of the year. Technology uses include multimedia, electronic presentations, and HyperCard stack development. A sample student developed database and HyperCard stack will be demonstrated.

Technology: A Natural Bridge Between School and Community

Bronwyn Rhoades, David Smith, and Larry Martin
Mendocino High School, Windows to the Future
Mendocino, CA

Abstract

Technology allows a natural connection between school and the world. Our students use video, computers, audio and the Internet to dissolve the classroom walls. Working with the Autodesk Foundation, latest connection plans include installing and managing Internet Node on the high school campus.Students are using autoCAD to design the physical space which will house the work station. The school then trains student and adult network managers, thus providing on-site apprenticeship. Once installed, the high school offers network "connectivity" to local businesses and educational institutions.

Current partnerships with higher education include:
- University of Arizona- Imaging Processing (Apple Classrooms of Tomorrow)
- University of California, San Diego- Authentic Assessment & California State Literature Project
- University of California,Irvine- California State Science Project

Current partnerships with business include:
- NASA
- Apple Computers, Inc.
- Autodesk Foundation
- Olyoptics
- Vermont Software

In this restructured educational model we have adults and teenagers learning side by side. Students collaborate with educators in developing HyperCard grant proposals, and they are empowered to select and direct areas of educational concentration. The old divisions between the business community and the schools fade as students are interned in local technology aided careers (i.e. local software companies) or to design HyperCard driven multimedia presentations. Students complete the *Windows to the Future* program with a multimedia "power portfolio" and certificates of competencies in addition to a high school diploma.

The SCANS Report, American 2000 guides our restructuring efforts as we prepare our graduates for the new century.

Projects (T1.12)
Telecommunications

Internet for the Middle-Level Student—A World Without Doors

Scott Dixon
Boulder Valley Public Schools
Boulder, CO

Abstract

The irony of a world without doors is the number of doors we must navigate before the world is open for the student. Bringing the middle level student into the powerful world of the Internet is a thoughtful endeavor. This project outlines the steps involved in bringing Internet access to students at the middle level.

Our access to the Internet was offered as part of a collaborative research project involving the Boulder Valley School District, the University of Colorado, and the National Science Foundation. This access to the adult on-line community necessitates a formal contract between the student, parent, and teacher outlining proper use of the network.

The electronic universe is a community new to the students with its own unique culture and protocols. Experienced users, including the teacher and fellow students, must provide new users with an orientation into this expansive world. Before students embark on their independent journeys on the network they must acquire a basic foundation in telecommunications software, the basics of an operating system (e.g. UNIX), followed by a repertoire of commands associated with network resources.

Peer teaching, university technical support, and community mentorship provide a support structure which empowers students to explore beyond traditional boundaries.

Case Studies of K-12 Educators Use of the Internet

Margaret Honey, Andres Henriquez, and Katie McMillan
Bank Street College
New York, NY

Abstract

As access to the Internet becomes more and more of a reality for K-12 educators, there are a number of questions that arise concerning the effectiveness of the Internet as a resource for teachers and their students. The Internet represents a vast environment that links many different computer networks throughout the world. However, Internet activity is heavily slanted towards higher education academics and technically oriented professionals. While there has been growing concern about getting the K-12 community access to the Internet and its resources, there have been no reports or studies looking at what educators do with the Internet once they are connected.

The Center for Children and Technology has carried out a series of case studies which document and describe, from the teacher's point of view, the ways in which K-12 educators use the Internet. Both schools which have been using the Internet for a minimum of one year and schools that are at the beginning stages of telecommunications activity on the Internet are included. The case studies address the following questions:

- Who within the school is accessing the Internet? Who actually logs on and from where?
- What is their relationship to the other teachers? Do they act as a resource person and facilitator for other teachers who are interested in accessing Internet resources?
- How did the school or individual teacher get involved with the Internet initially?
- Is the school/teacher involved in a collaborative partnership with a university or with a regional Internet service around using the Internet? What is the nature of this collaboration. From the teacher's point of view, is it effective and fruitful?
- What kinds of Internet resources are being accessed? To what extent are these resources being integrated into teachers' curricula?
- What does the process of learning to use the Internet look like? What are the major difficulties, stumbling blocks, etc.?
- How is access to the Internet paid for?
- How does a teacher's initial vision of the Internet mesh with the realities of Internet use? Is this vision support, modified, or drastically revised?
- Is the Internet being used to cross professional boundaries? (e.g., are middle school science teachers talking to university or professional scientists?)

Using On-Line Resources in Designing Instruction

Douglas Hyde and Julie Furst-Bowe
Menomonie School District
Menomonie, WI

Abstract

Educators at all levels of education are beginning to rely on telecommunication technology for curriculum development and enhancement. Telecommunication technology may be used effectively to aid in all aspects of the curriculum development process, from sharing ideas across disciplines to the creation of specific units and lessons. Additionally, numerous electronic discussion lists and bulletin boards are available for educators and students to use as forums to discuss issues and ideas and seek assistance from other educators throughout the nation and throughout the world. Immediacy of response is just one attribute of this form of communication and lends new meaning to the term "networking."

This presentation will provide an overview of on-line resources for educators and students which are available for no cost or a minimal cost to most educational institutions. This presentations will discuss a joint project which the presenters, Doug Hyde and Julie Furst-Bowe, are conducting this year in Menomonie, Wisconsin. Hyde, a media specialist for the Menomonie School District, and Furst-Bowe, an assistant professor at the University of Wisconsin-Stout, will explain how they share on-line resources to evaluate software and design instruction in a wide variety of subject areas. Students are then encouraged to use the materials they select and develop in their student teaching or internship experiences.

By using existing networks, commercially available software and shareware, the presenters will demonstrate that it is possible to enhance communication, curriculum development, and instruction through the use of telecommunication technology. Students who are taught how to use this technology will be able to apply these skills in their careers.

This is a non-commercial project used for educational purposes only.

This abstract was taken from the author's originally submitted proposal

---

Computers, Amateur Radio & Carl Hayden High School

Alejandro Reyes and Allan Cameron
Carl Hayden Community High School
Phoenix, AZ

Abstract

As soon as Veronica downloaded the weather fax of the eastern South Pacific, she tried to regain voice contact with Carlos in Argentina. They were sharing information about plans for the link with the space shuttle. Veronica's interest in school activities has increased since she earned her amateur radio license.

In the fall of 1991, the computer science department at Carl Hayden High School began the school's first amateur radio club. We wanted an activity that would reinforce computer skills and widen our students' interests in language, cultures, geography, and current events. With the help of local hams, we assembled an impressive computer controlled radio station:

- A transceiver system capable of communicating across the nation and the world.
- A packet station which digitally transfers e-mail, computer files, and on line keyboard conversations— a radio BBS.
- An amateur television station to transmit and receive local video and audio.

After one year, ten new hams are on our campus and many more students have joined the club. We are now offering classes, operating the station, assisting in emergency communications in the community, and assisting other schools in involving teachers and students in amateur radio.

Our presentation will cover the planning, financing, implementing, and operating of our amateur radio project. Carl Hayden Community High School and the Amateur Radio are non-commercial, non-profit activities.

Projects (T1.13)
Logo

An Inclusion Project Using Computers: Summer Fun in the City

Eileen Boyle Young
Spalding University
Louisville, KY

Abstract

Summer Fun in the City, a pilot inclusion project of the Council for Retarded Citizens of Jefferson County, Kentucky, was a two week, all day recreational educational program for students in special and regular education—children ages seven to fourteen with diverse abilities and disabilities. This project presentation will discuss one activity of the program: using computers.

This was a learning experience for both teachers and children; the teachers who worked with the campers using computers were, at the same time, enrolled in a workshop at Spalding University in Louisville, Kentucky, earning three graduate education credits. Because this program activity involved both campers and their teachers using computers, the working hypothesis was threefold:

- Using *LogoWriter* (LCSI) as their tool, all **children** can benefit from interaction with the computer;
- Working with learners in a Logo environment, **teachers** can increase their own understanding of how children think;
- As learning and social interaction tools, **computers and *LogoWriter*** can be integrated into any curriculum (even a recreational one).

The presentation will include learner activities for both the teachers and the campers, general operating procedures, evaluation of the project, and recommendations for replication of the project. (By NECC time, this project will be in its second summer).

Children's Experiences in a New Logo-Based Construction Environment

Sharnee Chait
Logo Computer Systems, Inc.
Highgate Springs, VT

Multi-processing and object-oriented programming are current buzz words in the software design community. What do these concepts mean to children? The field test of MicroWorlds, a non-traditional Logo environment, made multi-processing and objects accessible to children so they could design and build their own projects.

Project themes related to language arts, social science, and geometry. The children were in grade 5 and were somewhat familiar with another version of Logo. They worked in groups of two's and three's. The learning environment was constructionist in its approach. Children were encouraged to develop projects which were personally interesting, and to plan, design, and carry them out on their own.

Questions such as the following will be discussed:
Did parallel processing allow children to develop more realistic animations?
Did the use of objects make the environment more accessible?
What kind of group dynamics occur when children work together on a project?
What kinds of conceptual bugs did the children encounter?
What kinds of new projects emerged?

Problem-Solving with LogoWriter: The Magic of Math with Machines

Kathleen Maury
Mankato State University
Mankato, MN

Abstract

Teaching mathematics today can be most challenging and interesting. The National Council of Teachers of Mathematics has published documents which challenge mathematics educators to profoundly change the elementary and secondary school mathematics curriculum. The Council, in its "Standards for Curriculum and Evaluation" and its "Professional Teaching Standards," state that today's mathematics curriculum should teach mathematics with machines and encourage the use of computing machines to do and learn mathematics. It specifically encourages the use of Logo to accomplish that goal.

The purpose of this project is threefold. The primary goal is to teach mathematical problem solving within the dynamic interactive environment offered by computers. In addition, students become familiar with the mechanics of computer use, become familiar with the LogoWriter software in particular, and learn to think algorithmically using the microcomputer as an interactive tool. Also, students develop the ability to use the LogoWriter environment for their own mathematical problem solving, and the ability to teach mathematics lessons to elementary school aged children using LogoWriter as the tool. In the process of completing course requirements, students learn that mathematics is a dynamic discipline, and that machines can be used successfully to accomplish the goal of learning mathematics.

Pre-service teachers complete their teacher education program able to use technology within the school setting, use LogoWriter as a mathematics environment, and teach problem solving using the interactive environment of the microcomputer.

LARC Logo Teachers Shaping Their Classrooms: Logo Action Research Collaborative

Donna Rosenberg and Patricia Rowe
Boston City Public Schools
Boston, MA

Abstract

The Boston Logo Action Research Collaborative (LARC) is a continuation of a project designed to expand the role of Logo teachers in becoming teacher/researchers. Current research identifies teachers as key to school improvement and change, yet teachers are often by-passed and research findings ignored. Action research is research carried out by classroom teachers for the dual purpose of improving the teaching and learning in their own classrooms and informing other educators about what their students are learning.

Boston LARC supported Logo teachers in a year-long series of after-school meetings to take on new professional roles, conducting action research projects, observing the impact of their interventions, and evaluating the changes that were occurring within their classrooms and themselves.

The project leaders will present a brief history of LARC, the support strategies used as well as the preliminary findings about Logo learning, the change within the classroom, and the professional development which occurred within the group.

Projects (T1.14)
Teacher Training

Design and Training for the Classroom of the Future

Jacqueline Janik
Milwaukee Area Technical College
Milwaukee, WI

Abstract

This project involves the design of the facility, training of the faculty, and implementation with minimal programming support. The Classroom of the Future is a model classroom which will facilitate student learning through integrated, intuitive-controlled application of computer/AV technology. The environment will be flexible to support various modalities of learning such as group presentations, small group discussion, cooperative learning and independent learning. Information resources will provide interactive television and computer access with remote sites via networks or telecommunication links.

The presentation will include the process of design, the various interest groups involved, the initial successes, the search for existing materials, the preliminary development of materials, and the integration of these materials into the curriculum. The room currently functions as a classroom, but not a standard one. The Presentation System will be in place and functional for the Second Semester. The presentation will continue with the results of that semester and its implications for future projects.

The ABC's of Designing a Media Production Facility for Education Majors

Judy Lee
Southeastern Louisiana University
Kenner, LA

Abstract

The College of Education at Southeastern Louisiana University opened (September, 1991) a Media Production Laboratory (MPL) designed to provide: 1. resources, materials, supplies, and equipment for college students enrolled in educational methods and educational media classes; 2. a non classroom environment in which to introduce and train college students in the uses and applications of interactive technology; 3. a range of equipment from the basic to the high tech to be used to develop mediated instruction; 4. opportunities for faculty to teach teachers through interactive technology ways to use and integrate technology into their student teaching experiences; 5. opportunities for faculty to develop multimedia presentations for lectures, conference presentations, seminars, and workshops.

The facility is unique in that college students and faculty using the facility truly experience an interactive approach to learning at several levels. This approach is reflected by available equipment that ranges in sophistication from a dry mount press and a laminating machine (Phase 1) to a complete audio studio, video editing equipment, photography, and slide/tape programmer (Phase 2) to a Macintosh IIsi, CD-ROM and laserdisc player, scanner, laser printer and overhead LCD panel (Phase 3).

To ensure that students and faculty using the MPL are adequately trained and instructed, non graded workshops are periodically offered. The workshops provide instruction on operating equipment, information on production techniques, and suggestions for integrating educational media into the curriculum. Also, a graduate assistant is always available for assistance, supervision and instruction.

This presentation examines the steps involved in designing, developing and implementing a media facility for college students and faculty members. Policies and procedures, equipment, facilities, problems and solutions are some of the topics discussed.

Distance Teacher Education: Delivery of Graduate Instruction

Lois Ann Hesser and Al P. Mizell
Nova University
Ft. Lauderdale, FL

Abstract

Since 1972, distance education has been a hallmark of Nova University graduate programs in education. Where appropriate, technology has been used as an aid to instruction. The application of the technology is, perhaps, best demonstrated by its implementation in the Ed.D. Program in Child and Youth Studies (CYS).

The major delivery format for field-based programs (e.g. CYS) has been for a group of students to gather together in "clusters" where the faculty member is flown in once monthly for direct student instruction. In 1989, however, a new delivery system was introduced using personal computers and modems. Instruction could now be delivered directly into the student's home. Using these personal computers and modems to interact with faculty and classmates, students communicate through electronic mail and "real time" participation in electronic classroom (ECR) sessions. This new configuration has become known as the National Cluster.

Initial results of a three-year longitudinal study comparing the electronic delivery approach with the weekend cluster format are now available and will be a topic for discussion at this seminar. Examples of the materials provided doctoral students in the National Cluster, a description of the program delivery system, and student reactions will be shared.

Projects (T1.15)
Telecommunications

Project LA-Konnect: An Interactive Telecommunications Simulation Model

Sheryl Abshire, Donna Mancuso, and Diane Manson
Calcasieu Parish Schools
Lake Charles, LA

Abstract

Project LA-KONNECT is an innovative approach focusing on the use of telecommunications in an effort to make learning relevant through the use of current events for students in grades four through twelve. It is designed to provide curriculum connections and collaboration among the school system's departments, sites, faculties, students, and communities.

During the first semester, the high school students are designated as LA_KONNECT Coaches. As peer coaches, these students interact with fourth, fifth, and sixth graders using several modes of telecommunications. Their responsibility is to develop and send, via the electronic Bulletin Board System, a series of questions concerning weekly selected CNN Newsroom segments. This activity serves to build the foundational thinking and problem solving strategies necessary to effectively participate in a global simulation to be conducted during the second semester. The Coaches create a world crisis simulation scenario based upon current events. They monitor daily dialogue and proposed solutions over the BBS. The simulation is conducted for eight to ten weeks during the spring semester.

Each participating elementary and middle school classroom selects a country to study. The students role play citizens of that nation. The focus is on in-depth research of the nation's current political, governmental, economic, historical, cultural, and societal aspects. Other students serve as project monitors by portraying journalistic roles in all phases of the media. Students work cooperatively and collaboratively planning and reacting to the simulation events as they unfold via telecommunications. They agree by consensus to the crisis solutions that have been proposed.

As a culminating activity, all project participants assemble for a world summit. As a visible sign of their cooperative spirit, students pledge to uphold the conditions established by the summit.

This project presentation material is currently a non-commercial venture.

This abstract was taken from the author's originally submitted proposal

Learning Spreadsheets Using Stock Quotes from Prodigy

Sharon Andelora
Woodcliff School
Woodcliff Lake, NJ

Abstract

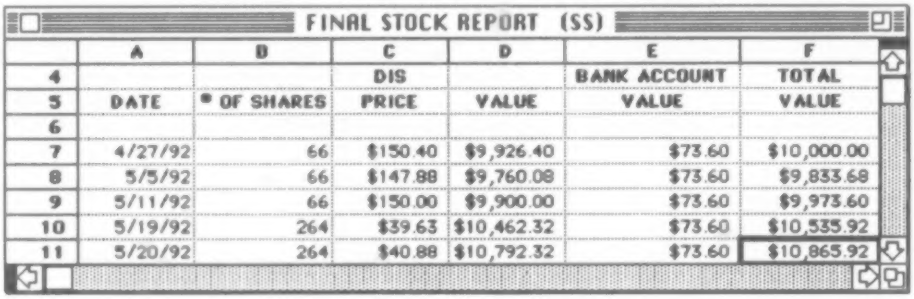
Before the class begins work on spreadsheets, we learn a little about the stock market, the reason for stocks, and how the business and world situations affect the price of stocks. Each student is given an imaginary amount of $10,000 to work with in this project. They are allowed to select up to three different stocks with this money. The remainder of the money is placed in a bank account. They are encouraged to discuss their selection with their parents, but the student makes the final selection.

The class as a whole makes up a spreadsheet chart as shown below. As we make up this spreadsheet, we discuss the types of cells, etc. Once we make up the spreadsheet, we are ready to insert the figures.

The class is then introduced to the stock market quotes on Prodigy, an on-line service. (Any on-line service would serve this purpose. If not available, the use of the stock market quotes in the newspaper can be used.) The first time the student uses Prodigy, he/she must locate and record the quote abbreviation. They find out the amount of the selling price. Using the calculator on the computer, the student determines how much stock can be purchased with the $10,000. The rest of the amount is put into a bank account.

Once a week, the students use Prodigy to find out the latest quotes of their stock and they add this information to their spreadsheet. This is a good chance to learn fill down and fill right commands. At the end of the class period, we find out which student's stock is worth the most that week. The name of the student is posted.

During the project, we discuss the fluctuations of the market and how world events have influenced the stock prices. At the end of the term, the top three students are given an award certificate for their achievement in this project. Since we can't predict the future, all students have the chance to be a winner.



FINAL STOCK REPORT (SS)

	A	B	C	D	E	F
4			DIS		BANK ACCOUNT	TOTAL
5	DATE	• OF SHARES	PRICE	VALUE	VALUE	VALUE
6						
7	4/27/92	66	$150.40	$9,926.40	$73.60	$10,000.00
8	5/5/92	66	$147.88	$9,760.08	$73.60	$9,833.68
9	5/11/92	66	$150.00	$9,900.00	$73.60	$9,973.60
10	5/19/92	264	$39.63	$10,462.32	$73.60	$10,535.92
11	5/20/92	264	$40.88	$10,792.32	$73.60	$10,865.92

A Case Study in Telecommunications in Education: The Holocaust Project

Shirley Hanein
New York University
New York, NY

Abstract

In recent years, educators have been concerned with teaching more than just the basics. Social responsibility and respect for human rights have become a greater priority with educators as incidents of harassment and bias increase. Through the use of telecommunications, students and teachers are able to transcend the boundaries that hinder the ability to be tolerant and respectful of those who are different than they. This presentation will focus on a bi-national telecommunications effort to study the Holocaust and Genocide with the goal of "promoting human rights and making students more aware of the disastrous consequences that can stem from prejudice and stereotyping."

Posters (T1.16)
Global Education

Global Classrooms: The Air Project
Rhonda Christensen and Gerald Knezek
University of North Texas
Denton, TX

Nola Campbell
Waikato University
Waikato, New Zealand

David Moore
Computer Command Corporation
Harlingen, TX

Environmental Awareness and the Use of ECOWIJS
Ries Kock and Mark Goedkoop
National Institute for Curriculum Development
The Netherlands

Global Education: A Family Affair
Raymond Fehr
Jefferson County Public Schools
Louisville, KY

Spotlight Sessions (T3.1)

Computer Training and Support: Lessons From Industry

Eliot Masie
Ziff Institute
Cambridge, MA

Abstract

Abstract not available at press time

Spotlight Sessions (T3.2)

Freedom and Justice...For All?

Carol Edwards
NFIE
Washington, D.C.

Jo Sanders

Rita Oates
Dade County Public Schools

Abstract

Abstract not available at press time

Spotlight Sessions (T3.3)

Integrating Telecommunications and Curriculum: Successful Experiences from Learning Network Mentors

Margaret Riel, Panel Chair
AT&T Learning Network
Encinitas, CA

Abstract

Currently, many educators are working to support and design technology that will connect classrooms and make possible new communities of learners. Developing the technical structure is only the first step of the process of creating these communities. Learning how to integrate telecommunications with classroom instruction and to collaborate with distant peers is the new skill that teachers and students need to develop.

This panel is composed of Mentor Coordinators from the AT&T Learning Network. These leaders in telecommunication have been sharing their expertise year after year with those who approach networking for the first time. They help new users learn how to work in collaborative groups to accomplish their educational goals. They will discuss classroom management and integration strategies that are effective for integrating telecommunications with classroom instruction.

Specifically, they will discuss:

1. The flexibility of Learning Circles and their fit with district technology plans and curriculum frameworks.
2. The commitment necessary for successful student learning through team work with others.
3. The ease with which teachers and students can telecommunicate. (Software concerns and technical support for beginners)
4. How the experience of telecommunications stimulates student involvement, creativity, and global awareness in their thinking and problem solving.

Panelists:

Larry Adamson
Live Oak Middle School
Live Oak, CA

Bill Burrall
Moundsville Jr. High School
Moundsville, WV

Dave Grott
Alden Place Elementary
Millbrook, NY

Sandi Norgaard
Village Elementary School
Hilton, NY

Lorraine Sherwood
Merton Williams School
Hilton NY

Marilyn Wall
John Wayland Elementary
Bridgewater, VA

Spotlight Sessions (T3.4)

Illumination: It's Elementary!

Fred D'Ignazio
Multimedia Classrooms, Inc.
Okemos, MI

Abstract

This session will show how elementary school students can use IBM's *Illuminated Books and Manuscripts* system to illuminate their own works that were originally authored as text files on an everyday classroom computer.

Everyone has learned about the five illuminated works contained in the *Illuminated Books and Manuscripts* system. Fewer people know about all the additional works that students and teachers can illuminate themselves. Almost no one seems comfortable with the most powerful feature of all: the ability of schoolchildren to create multimedia illuminations of their own original works.

In this session we will use the newest OS/2 version of *Illuminated Books and Manuscripts* to show original works written by elementary school children in East Lansing, Michigan. We will also describe how a teacher can organize students into authoring teams to develop their works collaboratively as a student-managed cooperative learning project that can take place while the teacher is conducting a normal class.

Society Sessions (T3.5)

Using Models and Simulations for Learning

Society for Computer Simulation (SCS)
Nancy Roberts, William Barowy, George Blakeslee and John Richards
Lesley College
Cambridge, MA

Abstract

This project is attempting to provide a theoretical base for the role of dynamic simulations in learning and problem solving. We are investigating what students can and do comprehend of dynamic computer models and if they are able to conduct their own investigations using these tools. We hope to understand how best to integrate simulations for optimal comprehension and transfer of learning from one problem to another.

The three components of this research are:

- Identifying and assessing the development and model-specific cognitive skills and the students' understanding of the nature and function of a model.
- Identifying and assessing the development of higher-order analytical cognitive skills and the students' ability to transfer these skills through different subject domains.
- Augmenting an existing model-based curriculum to facilitate implementation of the previous two components.

The study works with small group teaching, combining in stages animated simulations, the systems dynamics perspective, and microcomputer based laboratories, to understand the impact of each tool separately and then in combination.

Society Session (T3.6)

Methods for Teaching & Understanding of Computing for High School Teachers: Part I

Institute of Electrical and Electronic Engineers (IEEE)
Ez Nahouraii, Panel Chair
Industry Education Consulting
Los Gatos, CA

Abstract

This session is designed for High School Computer, Mathematics & Science Teachers, with the following objectives:

- To remove the mystery about computers
- To show how computers can be an aid to instruction
- To describe algorithms & how they are developed
- And to show examples of how to use computers to explore Mathematics & Science

It is presented by university professors, with the goals of developing an interest in computer science and engineering studies. It will also provide an opportunity for teachers to enhance their knowledge of computer science and engineering through the following brief non-technical presentations :

- Problem Solving & Algorithm Construction
- Anatomy of Computers
- Operating Systems
- Languages & Compilers
- Application & Examples in Mathematics & Science

This presentation is the first of a two-part series (see Society Session T4.3).

Panelists:

Michael Mulder, S. Landry, and Bradd Clark
University of Southwestern Louisiana
Lafayette, LA

Y. Patt
University of Michigan
Ann Arbor, MI

Society Sessions (T3.7)

A Bill of Rights and Responsibilities for Electronic Learners

EDUCOM
Frank W. Connolly
The American University
Washington D.C.

Sally Webster
SUNY College of Environmental Science & Forestry
Syracuse, NY

Abstract

EDUCOM's EUIT (Educational Uses of Information Technology) Program, through its Ethics Project working group, has developed a draft Bill of Rights and Responsibilities for Electronic Learners. This Bill of Rights is being widely circulated among the academic community in an effort to gather feedback, build a consensus, and finalize a document which can represent the viewpoint of the academic community. Other sectors, such as business and government, will then be brought into the process to create a comprehensive Bill of Rights and Responsibilities for Electronic Citizens that can represent the larger national information technology community.

At present, very broad participation is needed among the academic community. NECC '93 is a critical opportunity to reach concerned individuals in the K-12 community, as well as the higher education community, and involve them in the process so that the final draft will address concerns of all education. As networks from colleges and universities reach out into K-12 institutions, these issues continue to affect us all with increasing impact. Since NECC is a recognized leader in the area of policy affecting uses of information technology, we anticipate that NECC will be interested in fostering discussion and input into the document.

Ideally, the Bill of Rights would be the topic first of a plenary session, if at all possible, to reach the widest possible audience with a presentation of the concept. A follow-up session should also be scheduled where interested individuals can tackle the issues in working groups, provide critical feedback, and move the process closer to consensus.

Paper (T3.8a)

Computer Conferencing: A Course on Computers and Society

Alfred Bork
University of California
Irvine, California

Abstract

This paper reports on the use of computer conferencing within a course stressing the ethical, moral, and social aspects of computers and society. Computer conferencing is not used thus far as the total learning mechanism for the course, but only as one among several other mechanisms. The course is given at the University of California, Irvine.

The paper first describes the course, and then the role that computer conferencing plays. This method of discussion is compared with other possibilities.

The Course

The course in which this activity occurs concerns the ethical issues surrounding computer use in modern society. It is a required senior course for Information and Computer Science majors at the University of California, Irvine. The Department of Information and Computer Science at Irvine believes that informatics students who are about to graduate and enter the job market developing computer products should have some ideas as to how these projects influence the world. They should be cognizant of the social and moral issues connected with this development.

While almost everyone recognizes that the computer has exerted and continues to exert a powerful influence on our society, courses of this type are often not required, or even available, for computer science graduates. The topics covered in this courses are related to ethical issues in other areas, such as law and business. The course also has a second function within our department. Because one of our department's area of interest is the interaction of computers and society, this course serves as an introduction for others who might pursue this field further, either at the undergraduate or graduate level. We offer many sections of the course each year because it is a required class. At least four faculty members in the department have been involved in teaching the course.

While there is general agreement as to what the course is supposed to accomplish, the mechanisms used by different instructors are different. The description in the next few paragraphs refers to my variant of the course, and not to those taught by my colleagues, although certain features may be common.

My course involves three major pedagogical components. First there is a sizable amount of reading in the course. There are several articles assigned for each period, and in all variants of the course it is expected that students will read these articles. The articles come primarily from the professional literature concerning computers and society. The reading list differs for each instructor, and from year to year. Copies are available on request.

The second component of the course is discussion. This component, to the large extent that it is done, is unique to my presentation of the course. I do not lecture in the course. Rather each meeting is a discussion, based on the reading assignments for that week. In the early part of the discussion I stay out of the discussion, and even later I am more likely to ask questions than to pontificate. It is in connection with these discussion components of the course that computer conferencing is used, as will be seen later in this paper.

The third component of the course, again common to all instructors, but differing considerably in details, is writing. Students are asked to do a significant amount of writing in the course on topics related to the themes of the course. The course does not satisfy the upper division writing requirement required of all students at the University of California, Irvine, although it did so for a brief period of time.

Conferencing and Bulletin Boards

So far I have been using the term "computer conferencing." We do not have a conferencing system available, since there is no full scale conferencing system available on our departmental computers. Instead we use a bulletin board for the class, one for each of the periods in which computer conferencing plays a role in the class. It would be more desirable to use a conferencing system; however, as indicated, it is not available. With a conferencing system students would be free to start sub-conferences, spawning off discussions on particular topics that might be interesting only to part of the class. These do happen with the bulletin board too, and it would be possible to set up new bulletin boards, but the administrative procedures preclude most sub-conferences. Because these are computer science students, almost all at the senior level, most are familiar with the use of electronic mail. Some of the students will also be avid readers of other bulletin boards used within the department, or nationally. It is useful to have a small amount of instructional material on the mechanics of using bulletin boards within our environment. I will not discuss the material, as the mechanics differ widely from environment to environment. This discussion occupies only about five minutes in the class one day, and can be done mostly interactively, with knowledgeable students contributing much of the information. Written materials are also available if the student needs them. The system is UNIX, and the mail system is MH. Discussions Via Computer Conferencing The conferencing held via the bulletin board mechanism replace class discussions. When computer conferences were held the class was told it would not meet during that period, typically one or two periods, and that instead the reading assignment for that period was to be discussed through the bulletin board. Bulletin boards are set up in advance, and the students are urged to try the bulletin board, making certain they understood how to both read and send messages.

The system I used with the class was similar to that for ordinary mail. Letters could be addressed to the bulletin board by name, and a procedure is available for reading the bulletin board. There is a bit of clumsiness about this, unfortunately, due to default choices with the bulletin board, but these problems are quickly overcome by most students. I have already indicated that the software available was not ideal for the course. In advance of the first computer conference class time is devoted to discussing how the process should go. People are urged to read the bulletin board, at least several times a day. People were urged to make multiple replies, not feeling that they had done their "duty" to the class simply by writing one statement. Students were encouraged to conduct electronic discussions with other students, not just comments on the papers. That is, students were urged to comment on what other people were saying, and to continue these conversations over a sizable period of time. It was pointed out, although it did not need to be with a group of students with such professional backgrounds, that we are aware of how many messages they send to the bulletin board, and therefore how active they are. We made it clear that they should be spending about as much time in connection with the bulletin board as with the class itself. We also held a preliminary discussion before the first uses of the computer conference as a method of communication, comparing it with other methods of communication.

It is important to stress the difference between what happens in this class, and what goes on in the typical electronic pen-pal situation. The use of computers for students to talk with each other is not common, but has been tried many times. Often I find that these discussions lack any focus. Students do not know what to write about, and it becomes little better than pen-pals with ordinary letters, except that it costs much more and involves a good bit more in the way of arrangements of equipment, at least in a school environment. In this case students started from a set of reading materials, and the discussion was focused on those materials. Also they had already had class discussions, and so are prepared for discussions, independently of the electronic media. Hence this conferencing was far from a pen-pal activity.

Results

Generally discussions on the bulletin board are at the same level, or possibly higher, than the discussions in the class. The discourse was often not, however, at the depth one would have liked for particular issues, since I was not there to push people further into making comments on certain topics. The discussions, though, were more free, which also has advantages. Often discussions in classes are somewhat guided or even controlled by the professor. The quality of writing in general on the bulletin boards was quite high. In one situation where I team taught the course with another faculty member, we independently reached the conclusion that the writing we read on the bulletin board messages was of a higher quality than the writing we read on the term papers. At first this baffled us, but in discussing it individually with students a pattern began to emerge. It appeared that students viewed term papers as written just for the instructor, but it was their peers who are reading what they put on the bulletin board. So they generally took more care in connection with the latter writing exercise. This situation is not unknown in the writing literature generally where it is recommended that writing for peers be encouraged.

In comparing the on-line discussions with the classroom discussions, students do not agree. Most students liked the bulletin board discussions, and were able to articulate advantages and disadvantages. A major advantage of the on-line discussion is that people can think for a period before they react to another's comment. This does not necessarily turn out to be the case, but sometimes this thinking period was clearly valuable. Others, however, missed the fact that they could listen to the people, hear their tone of voice, and watch their facial expression in class. It was interesting that each year students could articulate these issues rather carefully, with no prodding from me, in discussions about the relative merits of the two methods of communication, after considerable experience with both.

Questions and Future Activities

Many questions arise about this kind of activity, and many possibilities exist for future experimentation. One wonders, in an issue already raised, how all of this would have gone with a well crafted conferencing system, as opposed to a bulletin board. There would be more for students to learn, and this might be a handicap. But, on the other hand, there would be some degree of flexibility, such as the spawning off of subconferences and the possibility of occasional voting, that were difficult to accomplish in the bulletin board arrangement. Different conferencing systems might be different in this regard. Use of conferencing systems has occurred in educational environments, but I know of no careful study in this regard. This is a unique case, true in most areas of education.

The present paper is impressionistic rather than a careful study. To conduct a careful study we would need thousands of students and far more resources than available to me. Another issue that might be raised in the future is whether more sizable segments of the course, or even the whole course, could be conducted through conferencing. There are experimental institutions in distance learning that do use the computer more extensively in the process, although not necessarily in the conferencing mode. Again, this is an issue that can only be resolved by full testing, and full testing at the many university level courses, not just a single course at a single institution. An entire course could be offered on this basis of computer conferencing. Such a course might be in a distance learning environment. Further trials of courses of this type would be useful. Another issue is how effective this method of learning might be for students with less technical background. As mentioned, I was dealing with senior computer science majors, although not necessarily students with much telecommunication experience. These people are willing to experiment with computers because they have been doing it for many years. How the procedure would work for a discussion course in Fine Arts, for example, is unclear. Probably we would need better software than we currently have. As with much of the software available today, our current software is not designed well for casual student users.

References

Hodgson, V. and McConnell, D. IT-Based Open Learning: A Case Study in Management Learning, *Journal of Computer Assisted Learning*, Vol 8, 1992.

Houghton-Alico, Doann. Delivering University Level Education through Computer Conferencing: Issue in Policies and Procedures, Part II. *Technical Committee on Computer Education Newsletter* Vol. 6, No. 2.

Stefik, Mark, Foster, Greg, Bobrow, Daniel, Kahn, Kenneth, Lanning, Stan and Suchman, Lucy, *Beyond the Chalkboard: Computer Support for Collaboration and Problem Solving in Meetings, Communications of the ACM*, Vol. 30, No. 1, Jan. '87.

Paper (T3.8b)

The Adoption and Diffusion of an Electronic Network for Educators

Julie A. Hamilton
Creighton University

Ann Thompson
Iowa State University

Background

The professional isolation of educators has long been a problem. Dan Lortie describes the "egg crate" nature of teaching, referring to the fact that typically, teachers are isolated in their classrooms and have little opportunity for interaction with other teachers and experts in their fields (Lortie,1975). Supporting Lortie's findings, Goodlad (1983) reports that teachers are generally confined to their classrooms and are unable to converse with other educators about problems or concerns.

The capabilities provided by electronic communication networks provide a possible solution for the professional isolation of teachers. Although research suggests electronic communication networks are currently being used effectively by educators the diffusion process of such networks has not been widely spread. With the development of electronic communication networks, an adoption/diffusion cycle occurs as potential users become aware of the innovation, judge its relative value, make a decision based on that judgement, implement or reject the innovation, and seek confirmation of the adoption/rejection decision. Dede (1990) stated that in order for an innovation to be seen as valuable by its target audience it must be perceived as being ten times better then the idea it supersedes. Electronic communication networks are one of the most recent technologies to begin the diffusion process through the educational system. Research on electronic communication networks is valuable to educators developing and managing networks. More specifically, research determining characteristics of early adopters and how they judge the value of such systems is necessary because this information helps researchers and developers understand and improve use of the innovation. The adoption/diffusion theory (Rogers,1986) provides a framework in which this research can be conducted.

Adoption/Diffusion of Innovations

With all new products and processes, an adoption/diffusion cycle occurs as potential users become aware of the innovation, judge its relative value, make a decision based on that judgement, implement or reject the innovation, and seek confirmation of the adoption/rejection decision. Dede (1990) stated that in order for an innovation to be seen as valuable by it's target audience it must be perceived as being ten times better then the idea it supersedes. Electronic communication networks are one of the most recent technologies to begin the diffusion process through the educational system. Research on electronic communication networks is valuable to educators developing and managing networks. More specifically, research determining characteristics of early adopters and how they judge the value of such systems is necessary because this information helps researchers and developers understand and improve use of the innovation. The adoption/diffusion theory (Rogers,1986) provides a framework in which this research can be conducted.

Rogers (1986) stated that the four main elements in the adoption/diffusion process are the innovation, communication channels, time and the social system. Rogers defined an innovation as an idea, practice or object that is perceived as new by an individual.

According to Rogers (1986), diffusion is the process by which an innovation makes its way through a society or specific group of people. The process of diffusion includes 3 components: 1) the innovation, 2) an individual or other unit of adoption who knows about or has experience with the innovation, and 3) a communication channel which provides a means of information exchange between the parties. Communication channels include two types: 1) mass communication channels, 2) interpersonal channels.

Diffusion is concerned primarily with the innovation and the adoption of the innovation. Following the introduction of the innovation, an evaluation process takes place on the part of the consumer. Diffusion of an innovation through a social system is determined by characteristics of the adopter and the perceived value of the innovation.

Early adopters have been found to possess common personal characteristics. In past research common characteristics of early adopters have been found in the categories of socioeconomic status, communication behavior, and personality traits. More specifically, research has concluded that personal characteristics early adopters have in common are their:

1. Education Level
2. Social Status
3. Social Participation
4. Cosmopolitan Outlook
5. Mass Media Use
6. Personal Communication
7. Degree of Innovation Information Seeking
8. Attitude Toward Change
9. Attitude Toward Risk
10. Aspirations
11. Attitude Toward Fatalism

According to Rogers (1986), adopters' perceptions of an innovation are also a vital element in the diffusion process. He has concluded that there are five dominant characteristics that adopters use to judge the value of an innovation. These characteristics include:

Relative Advantage - the degree to which an innovation is perceived as being better than the idea it supersedes.

Compatibility - the degree to which an innovation is perceived as being consistent with the existing values, past experiences and needs of the receivers.

Triability - the degree to which an innovation may be experimented with on a limited basis.

Complexity - the degree to which an innovation is perceived as being relatively difficult to understand and use.

Observability - the degree to which the results of an innovation are visible and easily communicated to others.

The adoption, implementation, and utilization of new communication technologies, such as electronic communication networks, can be studied effectively based on the theoretical framework of the adoption/diffusion theory. Diffusion of an innovation is determined by personal characteristics of adopters in a social system and their perceived value of the innovation. In order for an innovation to be successfully adopted within a social system a diffusion process, the process by which an innovation makes its way through a society or specific group of people, must occur.

Existing Networks

Electronic communication networks for teachers are beginning to develop throughout the world. Although networks normally focus on one aspect of education, such as science or art, they all share the philosophy of "bridging the gap" between educators. However, the networks vary in the number of services or options that they offer teachers. Some networks that are currently in operation will be described in the remainder of this section.

The College of Education at the University of Michigan is an institution using an electronic network for student teachers (Canning, 1988). This project involves the linking of 80 student teachers with outstanding teachers and administrators and the University of Michigan faculty. The main purpose for creating the system was to permit professional teachers, student teachers, and university faculty and staff of various backgrounds to interact and discuss questions about teacher preparation and to provide a system of support of student teachers. This system allows the users to communicate with each other by sending and receiving public and private messages. In addition, electronic conferences are frequently held on the network. The conferences focus on a specific topic such as mathematics. A specific menu is programmed on the network to support the conferences.

A similar project for teachers is in progress at the University of New Mexico (Bruder, 1988). CISCO-Net (Computers in Science Classrooms) was designed to link together thirty-five science teachers in remote areas around the state. The system has now expanded to 375 users including participants from seventy-five of the eighty-five school districts in the state. CISCO-Net not only offers electronic mail but two basic programming and reading courses, bulletin boards, student advisement, an electronic magazine, and sixteen databases for use by the teachers.

The Florida Legislature founded FIRN (Florida Information Resource Network) in an effort to electronically link all agencies, institutions, and schools in its public education system (Watson, 1986). The communication link, thought to be one of the most advanced in the nation, has three purposes: (1) to provide equal access to computing resources for all public education entities in the state for both administration and instruction; (2) to reduce the data burden on teachers and administrators while providing timely, high-quality data at all levels; and (3) to enable the rapid and effective exchange of computerized information within the public education system. Information exchange is taking place between 67 school districts and 33 area vocational technical centers, 28 community colleges, and the 9 state universities.

The Electronic Educational Exchange at Iowa State University

The college of Education at Iowa State University has developed an electronic network for teachers. The college is attempting to bridge the gap between the world of practice in the classroom and education faculty at the university via an electronic communication network entitled the Electronic Education Exchange (EEE). The EEE is designed to serve the following purposes:

I. Provide a convenient method for the exchange of ideas between student teachers, practicing teachers and Iowa State faculty.

- A. Decrease the sense of isolation often encountered by student and practicing teachers.
- B. To make faculty expertise readily available to student and practicing teachers.
- C. To increase faculty awareness of the problems frequently encountered by student and practicing teachers.

II. Provide telecommunications experience for student teachers, practicing teachers, and Iowa State faculty.

Research Questions

Research Question 1 (User Characteristics):

What are the characteristics of early adopters of the EEE?
Do user characteristics compare with characteristics found in completed research of other early adopters?

Research Question 2 (User Characteristics):

How do the users of the system perceive the system?
What was their initial perception of the system compared to their current perception?

Research Question 3 (Usage):

What usage patterns have evolved?
Has the frequency of use changed over time?
What caused the frequency to change over time?

Research Question 4 (Interactions):

What type of interactions do early adopters exchange on the EEE?
What are the most common educational topics addressed on the EEE?
With whom do the interactions occur?

Methods

Subjects

In order to conduct this study, a list of the most frequent Electronic Educational Exchange (EEE) users in the Spring of 1990 was generated. The most frequent or heavy users of the system were defined as early adopters of the innovation.

A total of 35 subjects were selected. The subjects consisted of 4 Iowa State professors, 4 Iowa State graduate students, 4 Iowa State student teachers, 2 Iowa State pre-service teachers, 1 professor outside of the university, and 20 educators from the state of Iowa and surrounding states.

Data Source

A questionnaire was used in this study. Research has suggested that personal characteristics early adopters have in common are: education level, social status, social participation, cosmopolitian outlook, mass media use, personal communication, degree of innovation information seeking, aspirations and attitude toward change, risk and fatalism. Therefore, the questionnaire collected data in these areas. In addition, research suggests that perceptions of an innovation directly affect the diffusion process. An additional section of the questionnaire allowed the early adopters to rate their initial and current perceptions of the EEE in five categories. The categories included relative advantage, compatibility, triability, complexity and observability.

Table 1. Reliability Calculations for the Early Adopter Survey

Category	Reliability
Attitude Toward Technology	.7116
Attitude Toward Risk	.7654
Attitude Toward Fatalism	.6298
Attitude Toward EEE Usefulness	.6881

Results

In general, the results of the study with respect to characteristics of early adopters were in agreement with Rogers. The average early adopter of the Electronic Educational Exchange can be described as:

1. possessing a Master's Degree or higher education
2. having an income of $30,000 or more
3. working as a classroom teacher
4. being approximately 39 years old
5. having 11 or more years in the field of education
6. contacting teachers outside of their school frequently
7. using various forms of media frequently

8. having a positive attitude toward technology
9. having an attitude that risk is necessary in life
10. having a neutral attitude on fatalism

A significant finding in the study involved the initial and current perceptions of the Electronic Educational Exchange (Table 2). The subjects were asked to rate the EEE, based on 5 categories, using a five point scale ranging from very high to very low. The mean of the initial perception was 2.41 indicating that the users felt the system ranked between average and high. Later, the subjects were asked to rate their current perception of the system. A mean of 1.92 was calculated as the current perception of the system, indicating that the users had a significantly higher perception of the EEE than when they began using the system. Overall, the data suggested that early adopters of the EEE were receiving the services they were seeking from the system.

Table 2 . Initial/Current Perceptions of the EEE

Perception	N	Mean	S.D.	T	2-Tailed Probability
Initial Perception	29	2.41	.682	3.31	.001
Current Perception		1.92	.476		

Message content and with whom individuals communicated was also compiled and evaluated. The subjects were asked to comment on "with whom they communicate most frequently" and "what their message content entails". The responses were similar. Teachers, Iowa State faculty, and graduate students were the most common users communicated with on the EEE. Media specialists and the system operator were also mentioned.

Message content was also similar among users; content categories included research, teaching ideas, educational technology, classroom management and personal messages. This suggested that the system was being used for professional development.

Educational Implications

Although research suggests electronic communication networks are currently being used effectively by some educators, the diffusion process of such networks has not been widely spread.

Research suggests that early adopters play a vital role in the diffusion process. They serve as a filter for the network. According to Rogers (1986), if the early adopters have a poor perception of an innovation, the innovation will be filtered out of the system but if the early adopters perceive the innovation as worthy they filter the innovation through the social system. Early adopters of the EEE were asked to report their initial and current perception of the system. The mean of the initial perception was 2.41 indicating that the users felt the system ranked between average and high. Later, the subjects were asked to rate their current perception of the system. A mean of 1.92 was calculated as the current perception of the system, indicating that the users had a significantly higher perception of the EEE than when they began using the system. Overall, the data suggested that early adopters of the EEE were receiving the services they were seeking from the system.

Rogers (1986) stated that early adopters of innovations possess certain characteristics and the present study supports his findings. In general, the study found early adopters of the Electronic Educational Exchange to possess these characteristics described by Rogers. Therefore, it is suggested to network developers that they individually seek individuals possessing characteristics similar to those of the early adopters of the EEE. Their use will increase the system's observability therefore, enhancing the diffusion process.

References

Bruder, I. (1988). Educational technology: Linking the great divide. Electronic Learning, 8(1), 50-54.

Canning, C. (1988). Computer networking for professional educators. Innovator,19(3), 1, 5.

Dede C. (June,1989). Future use of technology in education. Paper presented at the Annual Meeting of the National Education Conference, Nashville, TN.

Goodlad, J. (1983). A study of schooling: Some implications for school improvement. Phi Delta Kappan, 64(8), 552-558.

Lortie, D. (1975). Schoolteacher. Chicago: University of Chicago Press.

Rogers, E.M. (1986). Communication technology. New York: Free Press.

Watson, F. (1986) Florida Information Resource Network. Learning Tomorrow, 4(1), 99-110.

Paper (T3.8c)
Raising Consciousness Through Telecommunication

Indu Varma
Marshview Middle School
Sackville, N.B. Canada

P.K. Varma
Mount Allison University
Sackville, N.B. Canada

Abstract

This paper is about a telecommunication project in which telecommunication was used effectively in the area of Language Arts and Social Studies. Here, the magic of technology gave a new perspective to student learning. For the participating students, telecommunication opened the doors of many classrooms across Canada. In an incredible manner, sitting in their own tiny space of the classroom, these students were able to reach far out and learn through their involvement and personal contact with others in the study of practical, real life–based issues.

The project "Towards Raising A Canadian Consciousness" is one such venture where 63 Canadian schools from coast to coast were linked electronically. Telecommunication bridged the barrier of distance and the students felt closely connected. Through this link–up, students in British Columbia (on the west coast) could understand and share the concerns of those sitting in Newfoundland (on the east coast) as though they were next door neighbours. The students participated in a meaningful dialogue about three major issues contained in the proposed constitutional reform package – Distinct Society, Aboriginal Rights, and Senate Reform.

Three other activities evolving out of the project were – a Unity Pin, A Song of Unity, and a Unity Quilt. The students enjoyed working on the various aspects of this project, and in the process gained knowledge and a variety of skills, particularly higher order thinking skills.

Introduction

Telecommunication is a powerful tool of the Information Age. It allows the students to reach beyond the text books and the classroom walls. The magic of technology permits them to learn in unique and meaningful ways.

For the past two years Canadians have constantly pondered the issue of national unity. There have been serious discussions and negotiations at various levels of the government to keep Quebec within Canada. The country is faced with major constitutional reform towards building a renewed Canada. Canadians at every level have been invited to express their opinions about constitutional issues in a variety of ways, and thereby play a significant role in the shaping of the future of Canada.

With this background, the project "Towards Raising a Canadian Consciousness" was undertaken primarily to raise the consciousness level of Canadian youth about Canada. The intent, in more specific terms, was to promote mutual understanding, strengthen national unity, and build a collaborative culture amongst the youth through a meaningful dialogue about three major constitutional issues – Distinct Society, Aboriginal Rights, and Senate Reform. Furthermore, it was hoped that this project would give students the opportunity of gaining more knowledge about Canada and developing a deeper understanding of the critical issues that face Canada today by becoming actively involved in the constitutional debate.

Why Use Telecommunication?

Utilising telecommunication in the curriculum can make the learning of Social Studies and Language Arts an exciting odyssey. Effective use of telecommunication can:

a. Widen students' horizons through direct communication with students in other places.
b. Raise the social and cultural consciousness level and create a deeper awareness of the issues involved in the study.
c. Provide an exciting new perspective to the students' learning by taking them beyond the confinements of the text books and class room walls.
d. Be a powerful motivator for writing and sharing experiences where writing is done for a real audience.
e. Make learning more meaningful and relevant because it is in a personal context.
f Provide ancillary benefits for the students, such as, teaching them thinking and problem solving skills, and developing their self–esteem.

Source of Funding

The idea of getting students across Canada involved in a meaningful dialogue and bringing us a step closer towards national unity, became a reality mainly because of a major grant from the Secretary of State, Canadian Identity Branch. Partial funding was provided by New Brunswick Telephone company. Mount Allison University provided the technical support.

Set-up

From Newfoundland to British Columbia over 60 schools across Canada were linked electronically in this constitutional dialogue. The participating students ranged from Grade one to Grade twelve. "Envoy 100", an electronic messaging service, was used to set up an electronic bulletin board called, "Maple Leaf". The students in each school used their computer and modem to log on and read messages from "Maple Leaf" or leave messages for others to read. Thus, through this electronic network they were able to express their opinions, ask and reply to questions on the three chosen topics. The project ran for a period of ten weeks. To make it interesting and keep the dialogue an honest expression of opinions, initially every one was given a concocted identity. In the last two weeks the true identities were revealed.

Topics of Discussion

The discussion on the three chosen topics was based initially on the questions formulated by Mrs. Indu Varma's grade six students from the host school, Marshview Middle School located in Sackville, New Brunswick. As the questions were posted on "Maple Leaf" the participating students across Canada read them and sent their responses. In the process they also posed some questions of their own.

The students' comments are an indication of the seriousness with which they discussed and the understanding they acquired on the three chosen topics. As they probed deeper into the critical issues related to each topic, analyzed each other's point of view, evaluated the pros and cons of each issue and along the way, they also acquired some higher order thinking skills.

In this paper only a brief glimpse of some of the discussion that took place on the three chosen topics on the electronic bulletin board, "Maple Leaf" is presented. An attempt has been made to give a true impression of the students' opinions by using their own statements. References have been made both to the code names of the schools and to their actual names.

Distinct Society

The topic of Distinct Society is perhaps one of which Canadians from coast to coast have had heated discussions. The students involved in this dialogue also became quite engrossed in discovering what "Distinct Society" means in the context of Quebec and what the controversy about granting "Distinct Society" status to Quebec is all about.

The recurrent theme in this group's discussion was that each cultural group in Canada is distinct in its own way. The majority felt that all ethnic groups are distinct and no one group should be considered more distinct than another. Such a concept is ludicrous. Each and every Canadian is distinct in his/her own way. Students constantly referred to the large groups of Ukrainian–Canadians, Italian–Canadians, and various other ethnic groups as examples. They also pointed out that Native Indians of Canada are in a very strong position to claim the application of the term "Distinct Society" within the Canadian framework.

According to Big.Joe, "Every Canadian is distinct in his/her own way whether one is French, or English or Aboriginal, or from any other cultural background." Students strongly felt that French speaking Canadians are distinct, no doubt, but so are other Canadians. In their opinion the differences separating the French from other groups are their language and culture. They are Canadian people as much as every one else is, and thus should not be subject to favouritism.

In Rocky.Mountains' opinion (a school from Newfoundland) , "Behind a simple concept comes this difficult definition. Quebec is different than the rest of Canada. They speak mainly French, have a civil law tradition, and a unique culture. Yet there is that huge looming threat of an expanding English Canada overcoming French Quebec. At the same time Quebeckers are Canadians part of Canada. I would define a "distinct society" as a society, part of the longer more diverse society, a society which is different from the other minorities, but the same as a part of the big majority. A society which has to be protected and preserved, a society that deserves notice and a voice in its future. A society that is equal to all others, but very different than other societies. Just as a pound of stones and a pound of bricks are equal weights, yet very different substances, so is the "distinct society" of Quebec, different from the other societies of Canada."

Aboriginal Rights

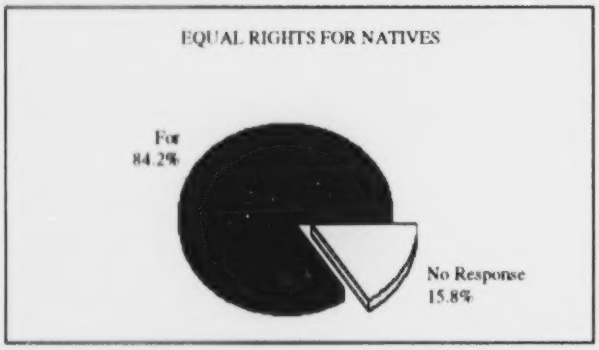
There was unanimous agreement among all the participants on the question of Natives' Rights. The students across Canada felt that all Canadians must be considered equal and must have equal rights, be they White, Native Indians, French or any other ethnic group. "Aboriginal and whites should have equal rights... When one race is treated better than another race, the result is racial tension between the two races which does not only affect a numbered few but the society as a whole which doesn't end in just one generation, but overlaps the generation gap which will hurt the country in the future," responds a Newfoundland School.

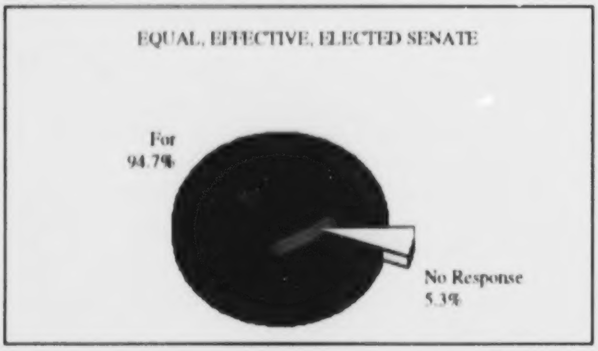
Students from Lewisville Junior High School, Moncton, N.B. feel that every one is the same inside. People should not be judged on the basis of their superficial features. We are all Canadians and must have the same rights regardless of our skin colour.

The response from Prairie.Wheat reinforces this view, " We believe that Aboriginal and Whites should have equal rights. All people, not just Canadians, are equal and should be treated equally. They should be given equal rights and respect. But even though the Aboriginal were the first to arrive in Canada, it does not mean that they should use this excuse to get special treatment. Different cultures, religions, and skin colour should not mean that a group of people should be treated differently or even have special rights." Marshview Middle School's class 6A reiterates the same opinion as shown in the graph.

The major debate in the present round of constitutional negotiations has been about granting self-government to the Native people of Canada. As the students discussed Aboriginal Rights they began to have a clearer understanding of what self-government might mean to the Native people. Prairie Wheat responds, "Self government to the Aboriginal people means that they want to make decisions for their own people instead of the federal government in Ottawa making decisions for them. They want a government for themselves to maintain their values."

A New Brunswick school gives a fairly clear idea of self-government for the Natives in the following statement. "The native people want to have a right to govern themselves in the following areas—[a] justice, [b] education, [c] language, [d] off reserve rights, and [e] women's issues."





Majority of the participating schools said that Natives should have self-government. However, both who were for and against the concept of Self-Government for the Native people wondered about the cost and who would pay for it. Students were unsure of the impact self-government would have; how, when and by whom it will be implemented; and would it mean extra costs for average Canadians? Without having a clear understanding and knowledge of the government's agenda for Native self-government, some schools felt hesitant to grant unconditional approval for Native self-government.

Senate Reform

Senate reform has been a hot topic of debate for Canadians. The proposed constitutional reform package suggested a EEE Senate—meaning an Equal, Elected, and Effective Senate. Most schools supported the concept of a Triple E Senate and the other proposed Senate reforms. A small minority felt that there is really no need to duplicate the work of House of Commons. In their opinion, the cost of maintaining this upper chamber would be too high. Hence, the present Senate should be abolished.

Generally, the students felt that the Senate must be Elected on an Equal representation basis in order to be Effective. The Senate must be based on equal numbers from all provinces and territories because the House of Commons is already population based. They felt that Quebec and Ontario should give up their traditional 24 seats, because if they don't and all others are granted 24 seats, the total of 288 seats would be an unrealistic size for a Senate.

"Yes, we think Canada should have a EEE senate because some of the old senators who have been there for years perhaps don't think that well. Some politicians appoint their friends as senators because they would help them pass the bills. In a EEE senate all the provinces would be equally represented," reiterate sixth graders of Marshview Middle School represented in this graph.

All 55 respondents from Magrath School in Alberta support Triple E Senate. In their view, "It takes into account regional differences and protects minorities. The House of Commons offers representation by population."

A Quebec school also endorses Triple E Senate. Their reasoning is, "Equality is the backbone of our society and we need to protect it." All 100 participants from Sherwood Heights Junior High School say "Yes" to a Triple E Senate. Manitoba's answer to the Senate debate is, "If we must have a senate, let's have a EEE Senate."

Project Expansion

The initial plan was to involve the schools across Canada in a meaningful dialogue about the three constitutional issues only. However, since the proposed topics were quite complicated for some of the young elementary school students, changes in the initial plan had to be made in order to achieve the stated objective of raising the consciousness level of our youths about our country, Canada. Moreover, growing concerns among the participants about national unity prompted Marshview Middle School's (the host school) grade six students and their teacher to add three unity related activities. These were – A Unity Pin, A Unity Quilt, and A Song of Unity. These three initiatives were chosen to ensure greater participation from all of the schools. It was felt that though the young grade one or two students could not post messages about the serious constitutional debate, they could certainly express their feelings about Canada through their quilt squares, pins, or song verses. The response from the schools was tremendous, and the results have been astounding. A brief description follows.

Unity Pin

The students across Canada were invited to submit pin designs on the theme of Canadian unity. They were asked to think about Canada and through their pin design and portray the message of Canadian unity. The chosen pin design, by Jason Rose, a grade six student of Marshview Middle School, has fleur-de-lis inside a maple leaf, giving the clear message of wanting to keep Quebec within Canada.

Unity Quilt

For the Unity Quilt students in every participating school were asked to think about National Unity and portray their message in the form of figures, symbols, or words on their quilt square. A cloth square was sent to each participating school across Canada with instructions to the students to use their imagination in designing a special quilt square that would focus on the theme of Canadian unity. Students were encouraged to use applique, fabric paints, embroidery, or any other medium of their choice to express their message. The quilt assembly was accomplished in Sackville with the help of parents of 6A students, teacher aides, and other volunteers.

The quilt is a beautiful work of art reflecting the strong feelings of Canadian youth about Canada and their concerns, fears, and hopes about the future of this country. Quilt squares reflect that from coast to coast Canadians love Canada and want to keep this country together despite vast cultural diversity amongst various provinces and regions of Canada.

A Song of Unity

"A Song of Unity" has been a unique undertaking. This song, according to Canadian Broadcasting Corporation, is perhaps the first of its kind to be completely written, composed, and performed by students. The manner in which the song was put together was quite unusual. The chorus lines were written by 6A students of Marshview Middle School. These lines were then posted on our electronic bulletin board, "Maple Leaf" and students across Canada were invited to send lines to make up the verses of this song. Soon lines and verses started coming from different provinces of Canada, such as, Saskatchewan, Alberta etc.. Though the verses came in bits and pieces from different provinces of Canada, the end result has been an amazingly beautiful song.

A grade six student of Marshview Middle School, Amanda Harpell, composed the musical score. As the verses came, Amanda and a group of students fitted the music to the words. The song has since been professionally recorded at Mount Allison University Chapel in Sackville, New Brunswick. It is a unique reminder of the feelings of belonging together as proud Canadians that these young participants experienced. The song is, co-incidentally, exactly 125 seconds long, as if just made for Canada's 125th birthday. The words of the song follow.

A Song Of Unity

Intro: (Instrumental)

Chorus
Canada, Canada, celebrate, celebrate,
Free for you and me,
With us together come celebrate, celebrate,
A hundred and twenty five years.

Verse 1
Canada's great, Canada's fine,
Canada's yours and Canada's mine,
Canada come, join us we'll have
Lots of fun on 1-2-5.

Verse 2
Of beautiful lands, part of our Canada
We hope they'll stay together.
The mountains, the prairies, the oceans and hills
Tie us together in one family.

Chorus

Verse 3
Kids would like to have a part,
This is the way to make it start,
Straight form the heart, we've done our part
Stay together for ever.

Verse 4
Time is gone, time is past,
Time is now to make it last.
Sea to sea, a place so true
There's acceptance for me and you.

Chorus

Measure of Success

The unique ways in which learning in this project took place indeed demonstrate the far reaching and magical impact that technology can have on students' learning. The project has been a marvellous experience for the participants and the learning acquired through this project will perhaps have a lasting impression on the students. The project did accomplish its mandate of raising the consciousness level of our youth about our country Canada. The participants gained a deeper understanding of the constitutional issues discussed, learned a lot about Canada, had a greater appreciation for Canada, and in the process also acquired a variety of skills prescribed in the curriculum in an enjoyable and meaningful way.

The concrete results of this project – The Unity Pin, Unity Quilt, A Song of Unity, and the dialogue on Envoy – are undoubtedly a measure of its success. However, the icing on the cake was the invitation to display this project in Ottawa at the Super Exhibition from Aug. 20 – 30, 1992, The project director was invited to exhibit the quilt at the Super Exhibition and she was asked to bring a team of teachers to Ottawa to conduct interactive workshops where the participants would be making more quilt squares and murals. Canada 125 fully sponsored nine teachers from across Canada to extend the experiences of the project, "Towards Raising A Canadian Consciousness". During the course of the exhibition the children, youth, and adults created marvellous things. The quilt blocks, scrap books, murals, birthday greetings to Canada, and video taped messages made at the exhibition will be packaged in 13 presentation boxes to be sent to Lieutenant Governors of each of the 10 provinces and 2 territories and the Governor General of Canada.

In conclusion, it can be said that effective use of technology in the curriculum can open new vistas and provide unique learning experiences. The above description of the project, "Towards Raising A Canadian Consciousness" clearly points out that incorporating telecommunication in the curriculum can provide exciting opportunities to expand the horizons of our students and thus prepare them for future challenges.

Paper (T3.9a)
Information Searching Behaviors and Attitudes

Shu-Hsien Chen
Cedar Shoals High School & University of Georgia

Abstract

This paper investigated the information searching behaviors and attitudes of high school students using an online catalog. Fifty students, randomly selected from four English classes, were required to use an online catalog, search for bibliographic information, and then fill out a questionnaire at the completion of search problems. The results indicated that students conducted online catalog searching with various levels of success. The success rate for author searches was 73%, title searches 61%, keyword searches 58.8%, subject searches 58%, and call number searches 46%. Ninety percent of students stated that they were satisfied with their online searching. The implication is that teachers and media specialists need to teach key word concepts when giving lessons on online catalog use. Also, they must stress the importance of accurate interpretation of search problems and careful review of search results so that needed information can be located.

Introduction

For the library professional, the early 1980s heralded an important epoch of change from card catalogs to online catalogs. These years began a period of experimentation with online catalogs in many large academic, special, and public libraries as well as a few school library media centers. This era also saw the beginning of library user studies. The rapid increase of online catalogs in libraries has been almost matched by the growth and expansion of online catalog research activities (Hildreth, 1989).

Most online catalog studies examined adult users' behaviors and attitudes (Ashoor & Khurshid, 1987; Matthews, Lawrence, & Ferguson, 1983; Stark, 1984; Watson, Williamson, & White, 1986). The national survey of the Council on Library Resources (CLR) investigated thousands of users and nonusers of online catalogs in 29 academic, special, and pubic libraries. It represents the earliest and the most extensive research effort on online catalog use (Matthews et al., 1983; Markey, 1984). This survey disclosed the high levels of success and satisfaction with online catalogs experienced by a majority of respondents. Eighty percent of users were satisfied with the results of their searches. Eighty-five percent of online users found relevant materials in their searches, and half of them discovered some interesting materials for which they were not searching. Seventy-five percent expressed their preference of the online catalog over a card catalog. Non-users, though with no prior hands-on experience, also expressed a very favorable attitude toward the online catalog.

In the CLR national study, a small number of young users in their teens were found among survey respondents (Markey, 1984). The study indicated that these youngsters accepted the online catalog even more readily than adults. Their enthusiasm and exuberance was fully evident in a group interview conducted with a class of sixth graders in Iowa City (Markey, 1984). They enjoyed this new technology as if it were an electronic game.

The study of Edmonds, Moore, and Balcom (1990), examining search performances and attitudes of children in grades 4-6, indicated quite the opposite results from those reported in the national survey. Edmonds et al found that out of a total of 207 subjects who were taken to a public library with an online catalog for this study, only 33 children preferred the online catalog, while 140 would choose the card catalog if given a choice. This study revealed that the success rate of children using the online catalog versus the card catalog in seeking information was 10% compared to 65%. The study concluded that children did not use the online catalog as effectively as a card catalog.

Another online catalog study showed that high school students were moderately successful in using an online catalog called Mac Library Access Program (MacLAP, 1989) after they had been given individual instruction (Chen, 1992). Their success rate for author searches was 69%, title searches 67%, and subject searches 60%. Chen indicated that in spite of some difficulties, students liked the online catalog, and they were persistent in searching. This investigator suggested that a lack of basic skills and limited capabilities of the online catalog system might have posed some barriers to effective and efficient online searching.

Craver's study (1988) involved a group of college-bound seniors in a laboratory high school affiliated with the University of Illinois. The researcher investigated the impact of availability of the university online catalog in the school media center on students' bibliographic citations in their research assignments. This study showed that students who had online access to university libraries cited more materials from the university libraries than students who did not have similar access.

Few studies have been found in the literature about online catalog use by school students. As more and more school library media centers replace the card catalog with the online catalog, it seems imperative that more studies are needed to investigate search behaviors and attitudes of school youngsters when they use the online catalog.

Purpose of the Study

The purpose of this paper was to investigate the performance of high school students as they used the online catalog to search for bibliographic information. In addition, how students react to their own searches was examined. Specifically, the study examined two research questions:

1. How successfully can high school students use an online catalog to search for bibliographic information when given search problems with clues about an author, a title, a subject (or topic), or a call number?
2. When using the online catalog, how do high school students feel about their overall search in each of five search types: author, title, subject, keyword, and call number as offered by the system? How difficult do the students perceive each type of search?

Methodology

Part of this study replicated the researcher's previous research on online catalog use (Chen, 1992). This present study was conducted in the same high school where MacLAP had been recently installed. MacLAP is an icon-based system using the Macintosh environment, which provides author, title, subject, keyword, and call number searches.

Subjects

Fifty students were randomly selected from four classes in the 11th grade to participate in the study. Subjects included 33 males and 17 females from an English course, which was taught by one teacher and geared toward average or slightly below average college-bound students. This teacher showed a predisposition in using technology and constantly scheduled the media center for class use. Thus, he would be an enthusiastic participant of the study.

Procedures

This study was carried out on a small group basis with two students receiving instruction and performing online searches in two separate sessions at one time. Students were given instructional orientation and actual practice using five search types—author, title, subject, keyword, and call number—to search for bibliographic information. The difference between a subject and a keyword search was brought to students' attention by using examples taken from the *Sears List of Subject Headings*. The first session lasted one class period, approximately 50 minutes. In the second session held on the following day after the initial instruction had been given, students were asked to use the online catalog to search for required information and write down their search results in provided answer sheets. Four examples of the search tasks are: (1) Find the author, call number, and publication date of *The Light in the Forest*; (2) Locate any book on problems of drug use by athletes; (3) Look up a non-fiction book on environmental protection; (4) List two of Isaac Asimov's publications on one (only one) topic in science. Upon completion of online searching, students filled out a questionnaire inquiring about their reactions to their searches in terms of the five search types.

Measurement Instruments

Two instruments, a set of search problems and a questionnaire, were used for data collection. The search problems, adopted from an online catalog study (Chen, 1992), were employed to measure students' search performance. Provided with clues about an author, a title, a subject area, a keyword, or a call number in the search problems, students were required to look for bibliographic information using the appropriate search types to answer 27 items of specific bibliographic information.

The questionnaire, formulated on a 5-point scale, was a simplified version of the questionnaire employed in the CLR's national survey (Matthews et al, 1983). The first part of the questionnaire asked students' demographic information; the second part inquired about their feelings regarding the degree of difficulty of the overall online search and specific search types.

Results

Success Performance

Success performance was based on the scores that students achieved in the search problems. The coefficient for success rate was calculated by using the following formula:

$$\text{SuccessRate} = \frac{\text{Number of Correct Answers}}{\text{Total Number of Test Items}} \times 100\%$$

Data analysis indicated that on a scale of 0-27, the maximum and minimum scores achieved by the students in the search problems were 27 and 5 respectively, with a mean of 16.82 and a standard deviation of 5.99.

The findings also showed that students had higher performances in author searches than in any other types of searches (see Figure 1). Students achieved a 73% success rate in the author search, a 61% success rate in the title search, a 58.8%

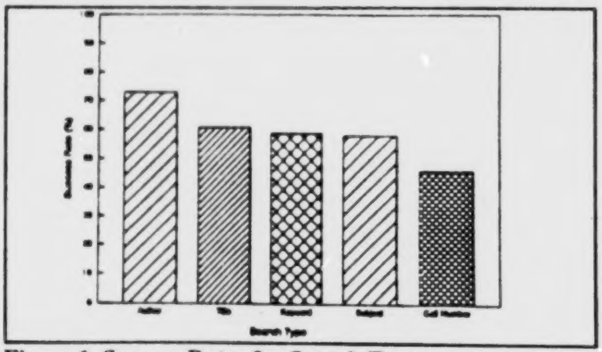


Figure 1. Success Rates for Search Types

success rate in the keyword search, and a 58% success rate in a subject search. Unexpectedly, they had the lowest success rate of 46% in the call number search when they were given a specific call number to search for a certain book.

Attitudes Toward Searches

Data gathered from the questionnaires indicated that a majority of students were satisfied with online catalog searching in general, with 58% of them feeling very satisfied and 32% feeling somewhat satisfied with online searching (see Table 1). Only 2% of students were very unsatisfied with online catalog searching, but no one indicated that it was a waste of time.

Scale	*# of students*	*Percent*
Very satisfactory	29	58%
Somewhat satisfactory	16	32%
Somewhat unsatisfactory	4	8%
Very unsatisfactory	1	2%
Waste of time	0	0%

Table 1. Overall Online Catalog Searching (N = 50)

To examine students' feelings (or opinions) toward online catalog searching, the questionnaire specifically asked them about their reactions to author, title, subject, keyword, and call number searches. Data analysis indicated that 90% (45) of the students agreed that a computer search by an author was easy and the remaining 10% neither agreed nor disagreed. When asked about their reactions to the search by title, 60% of the students agreed that it was easy and only 6% of students strongly disagreed (see Table 2). Table 2 also demonstrates that 44% of the students agreed that a subject search was easy while 22 % of them agreed a keyword search was easy. As for call number searching, 66% of the students agreed that the call number search was easy. Only twenty percent of them felt that a computer search by a call number was difficult.

Scale	*Author*	*Title*	*Subject*	*Keyword*	*Call #*
Strongly agree	0%	6%	6%	14%	8%
Agree	0%	14%	14%	26%	12%
Neither agree nor disagree	10%	20%	36%	38%	14%
Disagree	40%	30%	28%	20%	42%
Strongly disagree	50%	30%	16%	2%	24%

Table 2 Difficulty of Search Types in the Online Catalog (N = 50)

Discussion

As indicated in the research findings, the success rates for the five search types are as follows: 73% for author search, 61% for title search, 58.8% for keyword search, 58% for subject search, and 46% for call number search. When given definite clues about an author's name or a book title, students were more successful in locating bibliographic information for the former than for the latter. However, there is no significant difference in the success rate of students in performing subject and keyword searches when they were given search clues such as a topical area or keyword.

It seems logical that students found author searches easier than other search types. For an author search, students needed to select a correct search approach; invert the author's name with a comma; insert a space between the surname and the forename; and then enter the name correctly as provided in the search problems. In a title search students were required to omit the initial articles (a, an, the) at the very beginning of the title, and locate bibliographical information by choosing a title approach and typing in the book title. In the instructional session, students were taught specifically about these two particular features of author and title searches for the MacLAP system; however, it was probably difficult for them to apply these skills in just one class period. When typing an author's name, many students initially forgot to reverse the name order or leave a space after the surname and the comma. While entering a book title with a leading article, students might still use the title format as taught in English classes for reference citations in term papers.

Students' difficulties in reversing the author name or in eliminating the initial articles should be able to be overcome by a more friendly system design. An ideal online catalog system for school children should have the capability to automatically reverse an author's name order and also delete the initial articles for a book title.

In a subject or keyword search students had to think of an appropriate keyword or specific subject term. Subject headings employed in analytical cataloging are specific terms or phrases taken from the *Sears List of Subject Headings*, which is widely used in small or medium-sized school library media centers including this study site. General library users except professional librarians do not really realize the difference between a "subject," as generally used in the sense of a topical area, and a "subject," as used in the sense of tracings by librarians in cataloging books. Students at this age were inclined to enter different search terms by trial and error, hoping to retrieve search results. Although during the instructional session, students were shown the *Sears List* and told how to distinguish between these two terms, they probably could not fully grasp the concept in just one session. They might not have developed a habit to consult the *Sears List*. Although it was available for them to use during the search session, no one asked for it. Students appeared fully occupied at the terminals.

Keyword search is a powerful feature unique to the online catalog. Yet students seemed to have problems thinking of appropriate key words after they had read the search problems. As indicated in Chen's previous study (1992), students tended to enter the whole search problem as key words or type a long passage taken directly from the search problem. Consequently, their search performance in keyword searches was lower than in author searches where they could directly take an author as given in the search problems and type it into the computer.

It is interesting to note that there is no significant difference in the success rate of a title search and a subject or a keyword search. For subject and keyword searches, again a friendly online catalog should provide students with a suggested list of subject terms or keywords used in the system so that students may browse around and find proper search terms to enter. It should also have the capability to give a list of authors indexed in the system. It is surprising that students' performance for a call number search ranked at the bottom, with a 46% success rate. As in author or title searches, the key search term was also clearly given in the search problem; thus all students had do was select the call number approach and enter the call number. On examining the students' search answers, it was disclosed that only two students out of 50 left the search problem blank. All other 48 students chose the correct search approach and entered the call number, but unfortunately, they did not select a correct title from a list of potential search results displayed on the screen. In other words, a majority of students misinterpreted either the search problem or the screen information. As a result, they selected a search item that only partially satisfied elements of the search question.

Students' ratings of their own searches with regard to the five search types—author, title, subject, keyword, and call number—appeared to match their actual search success rates except in the call number search. Of the five search types, 90% students agreed that an author search was easy while no student disagreed. The second easiest search type was a call number search; 66% of the students agreed that it was easy. Next was searching by title; 60% of students agreed that it was easy. The fourth one in the difficulty level was subject search in which 44% of students agreed that it was easy. The most difficult search type, the students reported, was using key words to retrieve information. Forty percent of the students felt that keyword search was difficult while 22% of student said it was easy. In comparing students' search performances and their own ratings of difficulty levels, it seems that students understood well what were their problems in online catalog searching. Students' success rates in the five search types were roughly in inverse order to their reactions or perceptions regarding the difficulty levels in each search type.

The only exception was the call number search. Why did this discrepancy of search performances and perceptions occur? It seems that students' perception of the relative degree in searching difficulties reflects the amount of time and efforts needed to retrieve search results for a particular search type. While the students achieved a success rate of 46%, 66% of them perceived the call number search as easy. Forty-eight out of 50 students did not have any problems retrieving potential information on the screen, but many students failed to select a specific title to correctly answer the search problem. This particular problem required students to find a biology book being classified with the number "574.87" and at the same time published within the past four years. While students could easily access information via the call number search, they might not be aware that, out a list of four titles displayed on the screen, they needed to select a title that satisfied another element of the search problem, i.e. the specific publication date required in this problem. Misinterpreting or overlooking part of the information contained in the search problem could result in an incorrect selection for the answer. Failing to retrieve more detailed bibliographical information for each entry after a brief display could also result in selecting an incorrect title. Failure to review the search results or carelessness in evaluating them could have also caused problems for students. Thus, a successful search depends not only on retrieval of information but also on accurate interpretation of information included in the search problems and on the screen displays.

In general, online catalog searching was very satisfactory to a majority of students. Out of 50 students only 5 students felt it was unsatisfactory. Regardless of the students' ratings of the difficulty levels in the different search types, they all seemed very interested in using the online catalog and were persistent in the search process. When the search session was over, they still lingered, trying to do a few last minutes searching.

The last question in the questionnaire asked students to make any comments about using the online catalog. Students were exuberant in showing their favorable attitudes toward this new technology installed in their school. They found online searching "easy, fast, effective and convenient" to locate information. A few students admitted to some degree of difficulty in online searching, yet all showed positive attitudes toward it. One student commented that the online catalog was the greatest invention since Thomas Edison invented the electric light.

Implications and Conclusion

From the findings of the study, implications for instruction in use of the online catalog use will be offered. First, the ability to use key words is essential to retrieve search results via a keyword approach. Students must be informed whether the online catalog accepts one key word, key phrases, or both for searching. They also need to know whether the words in author, title, subject, or note fields are indexed. If the online catalog system has the capability to provide a list of authors or subject terms as references for users to consult, media specialists and teachers must alert students to these special features.

Second, the importance of accurately interpreting search problems and carefully reviewing search results cannot be over stressed. Online catalog technology is new to many elementary and secondary schools. In instructing in its use, the technical operation of the system tends to receive major attention of teachers and media specialists, when the fundamental source of online catalog searching difficulties resides in the academic problems of students. Students must have adequate English ability to accurately interpret information and review their search results based on what information the search problems asked for (Chen, 1992). Thus, it is crucial for students to have key word concepts and information interpretation ability to perform effective online searching. Students also need to be taught how to use subject headings displayed on the screen for more searches in a related area

In light of the recent development of online catalog technology for school youngsters and the increasing number of schools adopting this technology, there is no longer any question that online catalog technology is feasible for schools' small and medium-sized collections and library management. School students, even briefly exposed to it, used it with moderate success. They had the greatest success in author searches, as compared to the other four search types. Generally, their assessment on the difficulty level of a particular search type was reflective on their performance level of that type except that of the call number search. Even with some difficulty, students were very enthusiastic and persistent in online catalog searching. In the past, card catalog studies found that people avoided using the card catalog whenever possible (Lancaster, 1977). In this study, the online catalog stations were often occupied by students with many curious onlookers gathering around to watch some one else searching.

References

Ashoor, M. S., & Khurshid, Z. (1987). User reactions to the online catalog at the University of Petroleum and Mineral Library. The *Journal of Academic Librarianship, 13*, 221-225.

Chen, S. H. (1992). A study of online catalog searching behavior of high school students (Doctoral dissertation, University of Georgia, 1991). *Dissertation Abstracts International*, 53, 1133A.

Edmonds, L., Moore, P., & Balcom, K. M. (1990). The effectiveness of an online catalog. *School Library Journal, 36*(10), 28-32.

Hildreth, C. R. (Ed.). (1989). *The online catalogue: Developments and directions.* London: The Library Association.

Lancaster, F. M. (1977). *The Measurement and evaluation of library services.* Washington, D. C.: Information Resources Press.

MacLAP: User's manual. (1989). Cupertino, CA: Casper.

Markey, K. (1984). *Subject searching in library catalogs: Before and after the introduction of online catalogs.* Dublin, OH: OCLC.

Matthews, J. R., Lawrence, G. S., & Ferguson, D. K. (Eds.). (1983). *Using online catalogs: A nationwide survey.* New York: Neal-Schuman.

Stark, M. (1984). Using the online catalog effectively. *College & Research Libraries News, 45*, 301-305.

Watson, C., Williamson, S., & White, H. D. (1986). Resistance to online catalogs: A comparative study at Bryn Mawr and Swarthmore Colleges. *Library Resources and Technical Services, 30*, 388-401.

Paper (T3.9b)

New Approaches to Learning Geometry by Using GeoBlock

Kazuyoshi Hidaka
Tokyo Research Laboratory, IBM, Japan,

Satoru Yoshimura
Keio Gijuku University, Japan

Abstract

We propose new approaches to learning geometry through the use of a software tool named GeoBlock, which enables students to learn by drawing, changing, and observing constrained geometric figures on a computer display with a simple user-interface. These new approaches are assimilating theorems, conjecturing, learning through intuitive understanding, and discovery learning, through interactive manipulation of figures. We think that they are very effective for cultivating a mathematical way of thinking, problem-finding ability, and creativity, skills that will be essential in a highly information-driven society.

Introduction

Computers have been used widely in various activities related to mathematics education, particularly for drills and tutorial leanings, preparation of teachers' presentation aids, and, catching students' interest with graphics capabilities.

However, we think that computers can be used to solve fundamental problems in mathematics education, and that there is a very significant role for computers in this regard.

For a highly information-driven society, it is said that the focus of mathematics education in Japan must be shifted from merely teaching or understanding knowledge to cultivating a mathematical way of thinking based on intuition. We also think that account should be taken of problem-finding ability as well as problem-solving ability. Moreover, some people hope that mathematics education will cultivate students' creativity. We are confident that computers will play significant roles in satisfying these various social requirements.

In this paper, we propose four new approaches to learning geometry.

These are:

- assimilating theorems
- conjecturing
- learning through intuitive understanding
- discovery learning through the use of computer software.

These learning styles may constitute a basis for cultivating a mathematical way of thinking, problem finding ability, and creativity. We do not neglect the traditional approaches to learning geometry such as drills, proving theorems, and instruction-based learning using textbooks or notebooks. The point is that computers can be used to cultivate abilities that are not easily developed by the traditional learning styles.

Overview

The above new approaches to learning geometry are made possible by a sophisticated software tool called GeoBlock. GeoBlock (an IBM Japan domestic product) is a tool for thinking. Details of this tool are given in previous papers(Akaishi, 1992; Hidaka, 1990; Hidaka, 1992). With GeoBlock, students can draw and change constrained geometric figures graphically and directly, observe the animation of the process of changing figures, and measure and calculate lengths, angle values, and ratios by using the Mathematical Formula Editor (Nakayama, 1989). Figure 1 shows the screen of GeoBlock.

Geometric Supposer (Schwartz, 1989) and Cabri-geometry (Cabri, 1988) are other software tools for learning geometry. We think GeoBlock has more general constructing functions than the first, and a simpler and more familiar user-interface for students than the second. It is a geometric microworld in which a student can learn geometry by performing mathematical experiments.

New Approaches to Learning Geometry

Assimilating theorems

Using GeoBlock to assimilate theorems is an easy practice for novice users (students and teachers). For instance, a student first draws a triangle, and then puts a point P inside it (Figure 2(a)). Next, he draws three half-lines by connecting point P to each vertex. He can define three points of intersection with the edges of the triangle, and label them D, E, and F. Then he enters the mathematical formula, in order to calculate the product of the ratios in which these points divide the edges (Figure 2(b)). He can move point P freely, and observe that the product takes the fixed value irrespective of the position of P (Figure 2(c)). The result is famous as Ceva's theorem. The students can assimilate the theorem by drawing figures with "intersection-constraints' ' and observing the product. Many other theorems can be assimilated by drawing and changing figures. A general capability for constructing figures under geometric constraints enables students to assimilate a wide variety of theorems.

Conjecturing

An example of how GeoBlock can be used to form geometrical conjectures was given by M. Sasaki at Takehaya Junior High School in Tokyo (Sasaki, 1991). First, a student drew a triangle and the perpendicular bisectors of two edges, and defined the intersection of these bisectors (Figure 3(a)). Dividing-point constraints, inclination constraints, and intersection constraints are used to make this figure. Then the teacher asked students, "What condition determines whether the intersection is located inside or outside the triangle?" Changing the shape of the triangle, the students observed the ratio of the edges, and the relations among angles, and finally found the answer. That is, if angle A is larger than 90 degrees, the intersection is located outside the triangle. In this manipulating and observing process, the students made many geometrical conjectures. Moreover, they could check their ideas by continuing manipulations and observations. Some students were also able to find that the intersection always moves along the perpendicular bisector of the third edge (Figure 3(b)). Students were interested in finding problems through a process of conjecture.

Learning through Intuitive Understanding

Next, we show learning through on intuitive understanding. In Figure 4(a), points P and Q are located on the same side of straight line AB, and a point R moves along AB. The problem is, "Where is point R located when the sum of segments PR and QR takes the minimum value?" By using GeoBlock, we can reach the solution graphically.

First, we draw a figure corresponding to the one in Figure 4(a) (Figure 4(b)). Point R can be moved exactly along the straight line AB by dragging a mouse, because the "on-the-line constraints" has been set to it (Figure 4(c)). Next, we add a segment RS that starts from point R, has the same length as segment QR, and is parallel to segment PR. In order to draw RS, inclination and length constraints are used. Then we draw a circle by defining its center as point P and one point on the circumference as point S (Figure 4(d)). If we change the location of point R on AB, segments PR, QR, and RS, and circle PS are changed and re-drawn automatically by the system (Figure 4(e)). We must pay attention to the fact that segment PS is always equal to the sum of PR and QR (PR+QR), and therefore, that the radius of the circle is equal to this sum.

How is the radius of circle PS changed, when R moves along the straight line AB? This is the question which interests us. By dragging point R with the mouse, we realize that the size of the circle becomes smaller or larger, depending on the position of R. A good way to solve the problem is to reason that when the radius of the circle takes the smallest value, segment PS is smallest, and therefore "PR+QR" takes a minimum value.

Watching the size of circle carefully, we can determine the position of R that makes "PR+QR" the smallest. Obtaining the locus of the changing circle, we can specify the target position of R more clearly. Seeing the process animated, we are confident that our graphical solution is correct and that no other solution exists (Figure 4(f)).

Of course, the exact position of R needed to reach the solution is obtained by the geometric construction in Figure 4(g). We think the above graphical approach based on interactive manipulation on the computer's display can cultivate students' intuition in a way that is not possible with the conventional construction approach using a compass and a ruler. In this example, GeoBlock is used to solve the geometric problem by a graphical approach, not by a symbolic approach such as formulating a conventional proof based on construction.

Discovery Learning

These days, discovery learning is used experimentally in many mathematics classrooms. Learning with "Logo" is a famous example. Here, we take the problem: "What line dose the point P trace, when it moves under the condition that the angle APB is equal to the angle CPD (AB has the same length as CD)." Figure 5(a) shows a case in which ABCD makes a square. With GeoBlock, discovery learning starts with the students drawing figures and entering mathematical formula to calculate angle values. When the position of P is changed, the angle values are changed and recalculated automatically. If the value of "angle APB minus angle CPD" is between +0.5 and -0.5, the locus of point P is plotted on the display screen. By repeated operation and calculation, students arrive at the figure in Figure 5(b). Moreover students can try many other cases such like a rectangle, a quadrilateral, and a trapezium in the same manner.

We think this is a new style of geometry, because the conditions of angles have never been controlled on paper or in other geometry software. GeoBlock also makes possible the above new style of discovery learning.

Conclusions

We proposed new approaches to learning geometry by using computers. These approaches are assimilating theorems, conjecturing, learning through intuitive understanding, and discovery learning. We think that they are very effective for cultivating a mathematical way of thinking, problem-finding ability, and creativity for a highly information-driven society. Moreover, we pointed out that these approaches can be easily realized by a software tool called GeoBlock.

The approaches of assimilating theorems and formulating conjectures have been practiced in several classes in junior-high schools in Japan (Sasaki, 1991; Ise 1991). We are planning to practice more advanced use of GeoBlock in learning through intuitive understanding and discovery learning.

Reference

Akaishi, M.(1992).Mathematical Software as an Exploration Tool. Proceedings of NECC '92, pp. 145-151.

Hidaka, K.(1990).A Tool for Learning Geometry. *The Journal* of Science Education in Japan, Vol. 14, No. 2. Japan Society for Science Education.

Hidaka, K.(1992).Development of GeoBlock: a Micro-World for Learning and Teaching Geometry. Lecture Notes in Computer Science, No. 602, pp. 294-306. Springer-Verlag.

Nakayama Y.(1989).Mathematical Formula Editor for CAI. Proceedings of ACM CHI'89, pp. 387-392.

Schwartz J. L.(1989).Intellectual Mirrors: A Step in the Direction of Making Schools Knowledge-Making Places. Harvard Educational Review, Vol. 59, No. 1, pp. 51-61. Harvard College.

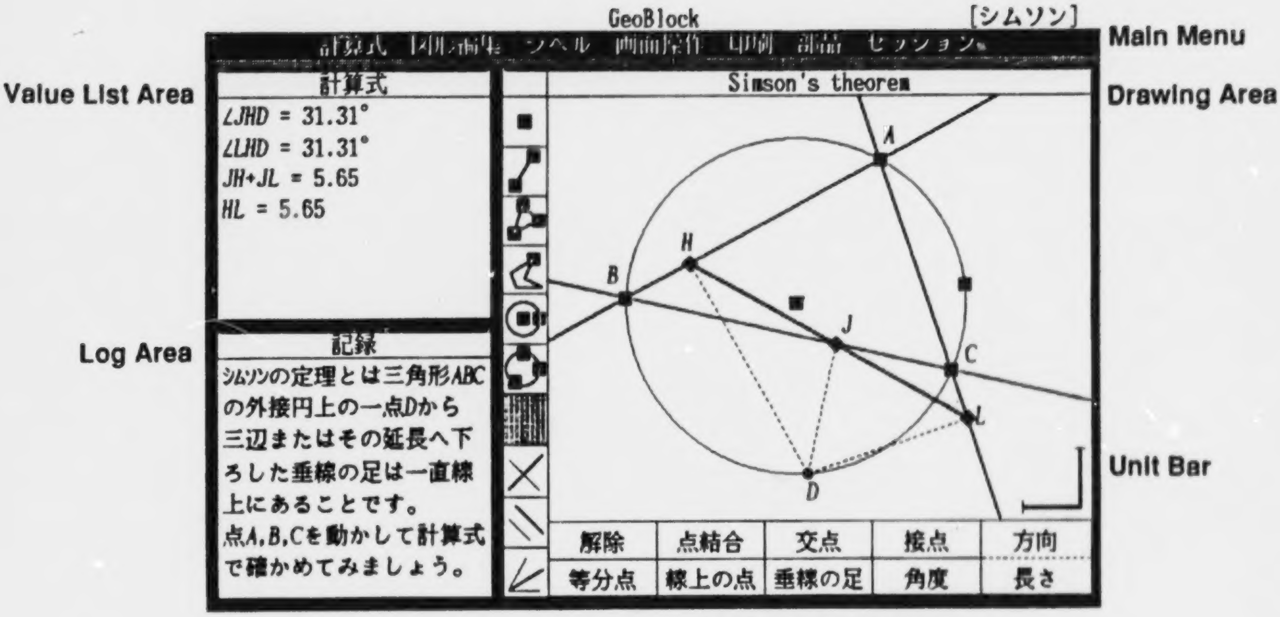
Cabri (1988).Cabri-Geometre: An Interactive Notebook for Learning and Teaching Geometry. User's Manual for Version 2.0. Laboratoire de Structures Discretes et de Diactique: Institut D'Informatique et de Mathematiques Appliquees de Grenoble Universite Joseph Fourier-CNRS.

Sasaki M.(1991).A Practical Use of a Computer in Mathematics *Education, Tokyo Gakugei Journal of Mathematics* Education, Vol.3, pp.87-97.

Ise T.(1991).Application Softwares in Classrooms. Research Report No. 3, pp.19-25. Information and Research Center for Educational Software.

Acknowledgments

We wish to thank Fumiyuki Terada (Waseda University), Muneaki Sasaki (Takehaya Junior High School), and Masahiro Udo, Toshiyuki Sanuki, Yasutomo Nakayama, and Masanori Akaishi (IBM Japan), for useful discussions during the development of the system.


GeoBlock
[シムソン]
Main Menu
計算式 図形編集 レベル 画面操作 印刷 部品 セッション
Value List Area
Drawing Area
Log Area
Unit Bar
Simson's theorem
A
H
B
J
C
L
D
解除
点結合
交点
接点
方向
等分点
線上の点
垂線の足
角度
長さ

計算式

∠JHD = 31.31°
∠LHD = 31.31°
JH+JL = 5.65
HL = 5.65

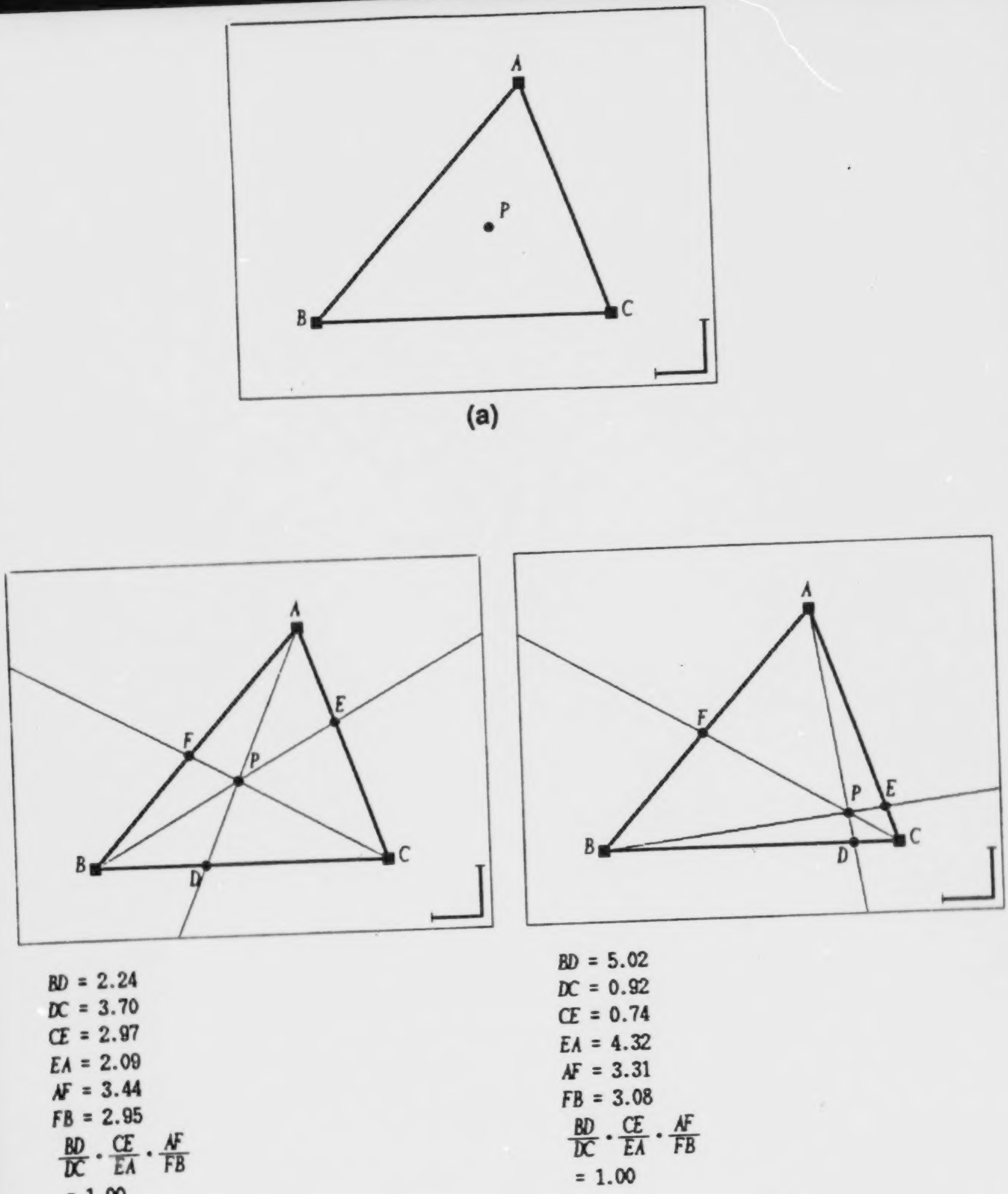
記録

シムソンの定理とは三角形ABCの外接円上の一点Dから三辺またはその延長へ下ろした垂線の足は一直線上にあることです。
点A,B,Cを動かして計算式で確かめてみましょう。

Constraint - buttons

Release, Link, Intersection, Tangent, Slope
Dividing point, Online, Perpendicular, Angle, Length

Figure 1. Screen of GeoBlock


A
P
B
C
(a)
A
E
F
P
B
D
C
A
F
P
E
B
D
C

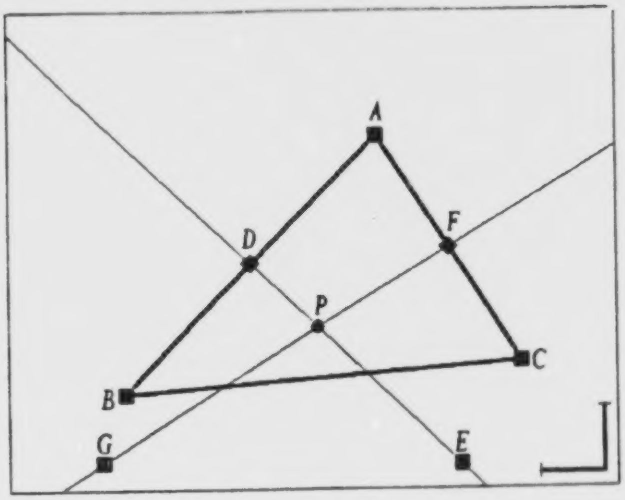
BD = 2.24
DC = 3.70
CE = 2.97
EA = 2.09
AF = 3.44
FB = 2.95
$\frac{BD}{DC} \cdot \frac{CE}{EA} \cdot \frac{AF}{FB}$
= 1.00

(b)

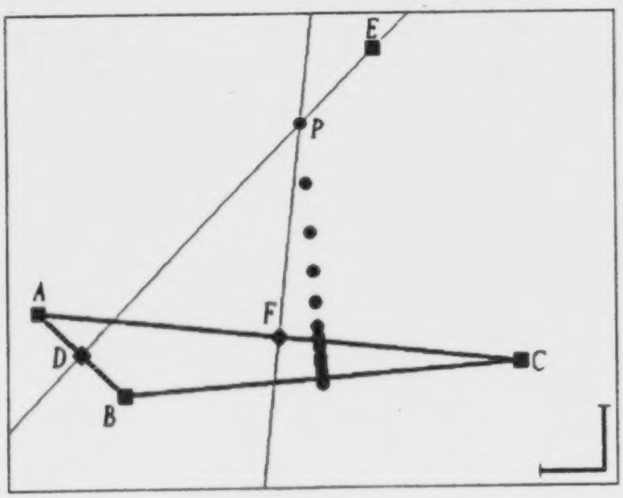
BD = 5.02
DC = 0.92
CE = 0.74
EA = 4.32
AF = 3.31
FB = 3.08
$\frac{BD}{DC} \cdot \frac{CE}{EA} \cdot \frac{AF}{FB}$
= 1.00

(c)

Figure 2

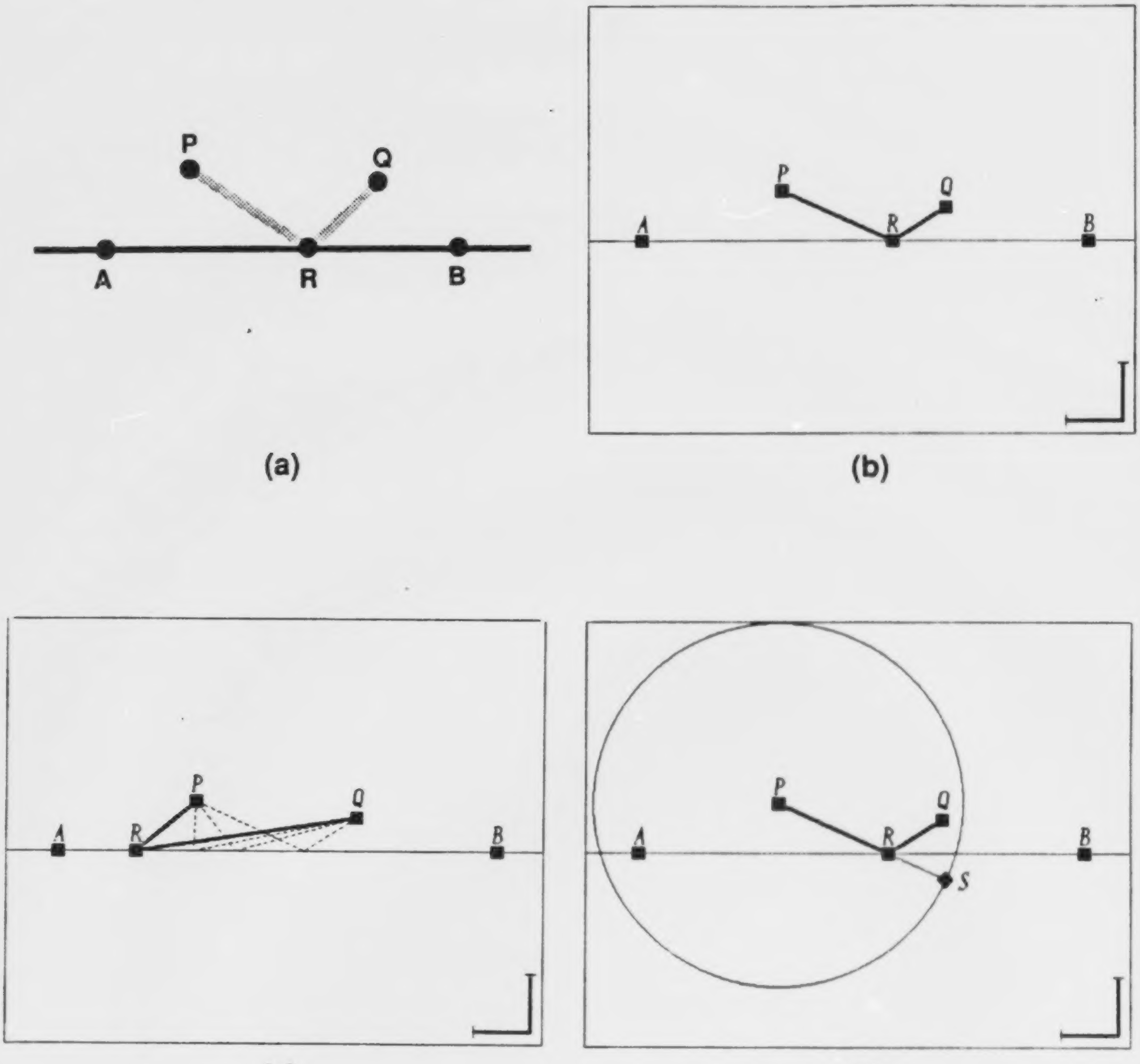


(a)



(b)

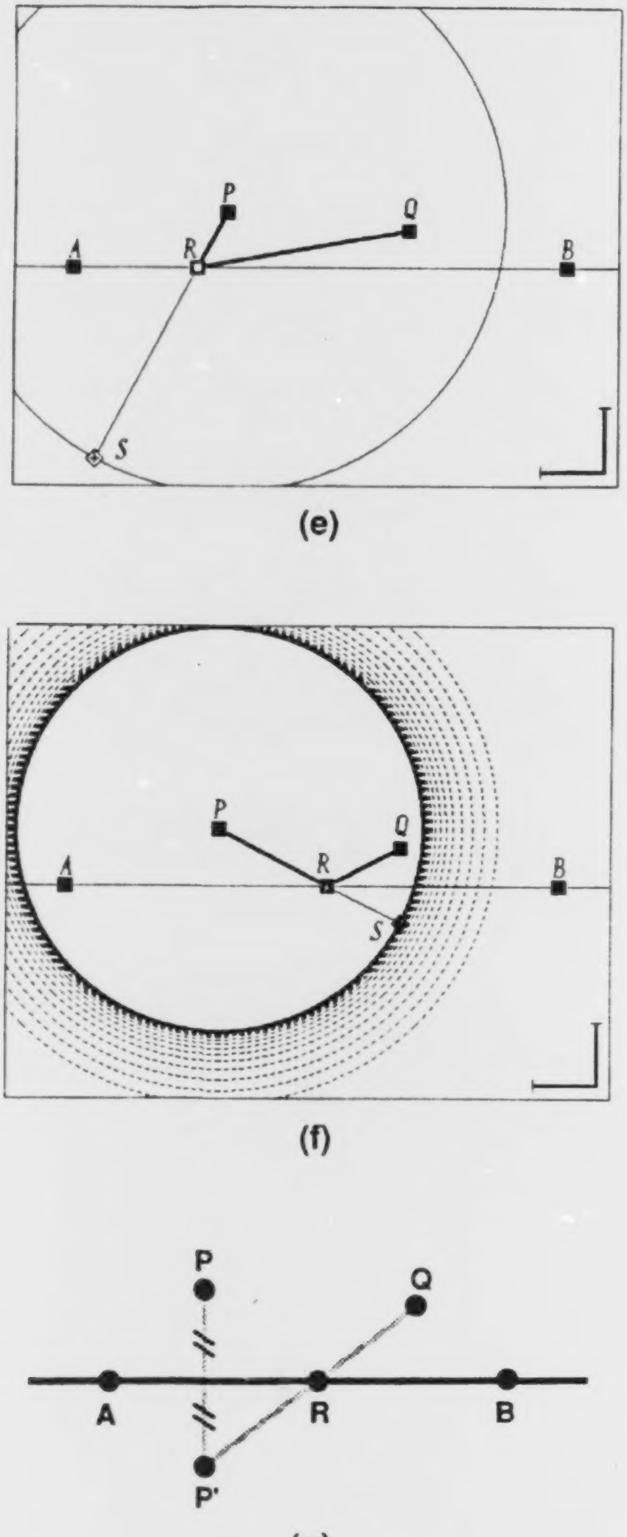
Figure 3



(a) (b)

(c) (d)

Figure 4

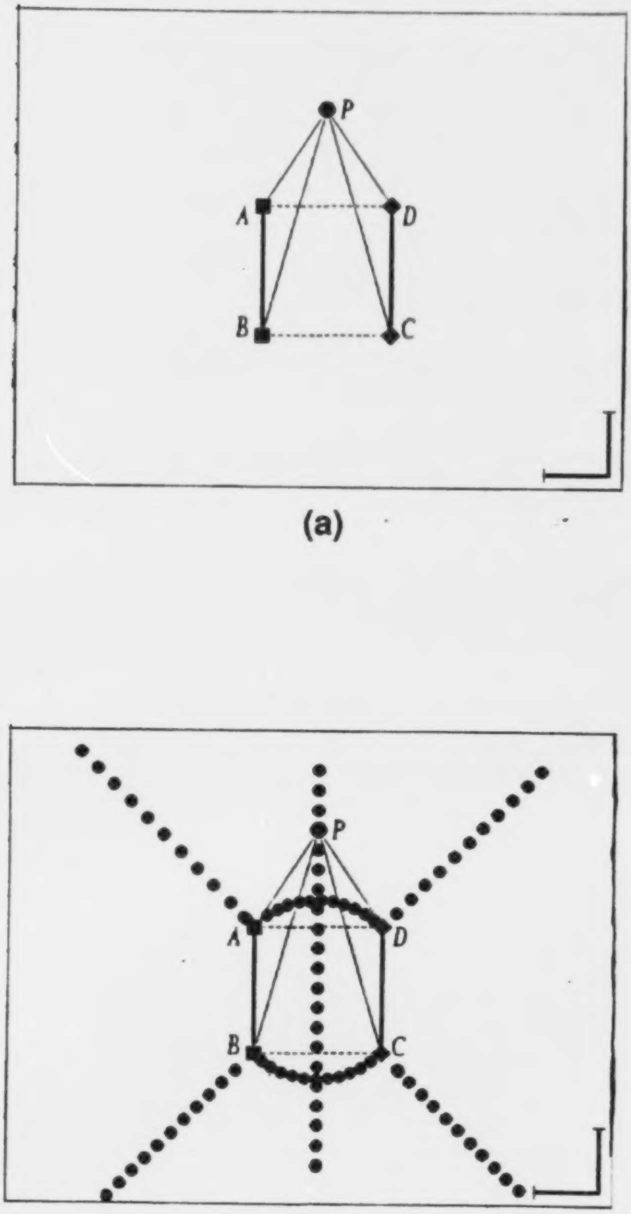

P
Q
A
R
B
S
P
Q
A
R
B
S
P
Q
A
R
B
P'

(e)

(f)

(g)

Figure 4 continued


P
A
D
B
C
P
A
D
B
C

(a)

(b)

Figure 5

Paper (T3.9c)
Evaluation of Writing Instruction Using Computers

Neal Schleifer
Sarasota County Schools
Sarasota, Florida

Introduction

Although there have been numerous studies on the effects of using computers in composition instruction, there is a paucity of concrete statistical results (Herrman, 1990; Hawisher, 1989; Davis, Scriven, & Thomas, 1987; Bridwell, Nancarrow, & Ross, 1984). Much of the evidence about using computers is anecdotal (Schwartz & Vockell, 1988). Teachers and students often report impressions that work has improved and that students write more. Yet results comparing computers and traditional paper and pen methods sometimes have been inconclusive, and some studies have been flawed (Hermann, 1990; 1989). Two related questions haunt educators: Does writing quality improve with computer instruction? And how can the results of computer writing instruction be evaluated? Simply put, have the students become better writers? And how can we tell? Is computer instruction accomplishing the perceived magic or are the subjects merely enamored of technology? This is an important question at a time when both the public and educators are calling for meaningful change, and allocation of limited resources is a pervasive issue. At the same time, many states have sought means for improving writing instruction. For example, Florida developed a Writing Enhancement Program for high schools and passed Gordon Rule legislation at the college level (Florida, 1990; Gordon Rule, 1991).

A means was sought, therefore, for evaluating student progress after an intensive nine week quarter of writing instruction. Quality of writing is traditionally rated by panels of holistic scorers, but this procedure is not practical for large numbers of students in most school districts. It is time-consuming and expensive. An instrument was needed which would be relatively fast, easy, and economical to use. A research of the literature indicated the Writing Apprehension Scale (WAS) (Daly & Miller, 1975a,b) could be helpful. The WAS has been tested extensively and other major writing apprehension scales correlate well with it (Daly, 1985). Moreover, a study for the Utah Department of Education (Shaver, 1990) verified the validity and reliability of the WAS for secondary school populations, and also developed The Attitude Toward Writing with the Computer Scale (ATWCS).

The rationale for using the WAS is based on research on writing apprehension which suggests that apprehensive writers have difficulty composing (Daly & Miller, 1975). Low writing apprehension correlates with high holistic scores, high SAT scores, success in writing courses, and improved achievement (Daly, 1985; Daly & Miller, 1975b). Writing Attitude Scores of Advanced Placement (AP) English students were compared to average students in the treatment and non-treatment groups. Advanced Placement English students in Sarasota County are selected by a screening that includes PSAT/SAT scores and a holistic writing sample scored by a trained panel.

For the average groups, the study determined if there was any relationship between WAS scores and gender, GPA, or ATWCS scores. Relationships between ATWCS scores, gender and prior computer experience also were examined.

The WAS is a 26 question test instrument that uses a 5 point likert-scale, and the ATWCS has 9 questions (35 questions total; See Appendix I). This administration followed the common practice of reversing the scales so higher scores indicate writing attitude or lower writing apprehension. In addition, the following demographic information was requested: Grade level, gender, number of classes requiring in-class use of computers, and grade point average (GPA, verified through guidance department records).

Results

The instruments were administered as Pre and Post tests to 212 seniors and 22 AP juniors at Riverview High School in Sarasota, Florida in the fall 1991 semester (N=234). The instruments were first administered in August and then again in October at the end of the quarter. AP juniors were used because the AP seniors already had the computer writing treatment in their junior year. The AP screening indicated these juniors were prepared to write at a college freshman level.

WAS.

The differences between the subjects' pre and post test scores on the WAS were analyzed by paired t-tests. The differences for the treatment group were significant at the .05 level, but the differences for the non-treatment group were not significant (Tables 1 and 2). Therefore, student scores on the WAS improved significantly after computer treatment.

Table 1

Paired t-Test for the Computer Group Writing Attitude Scale Scores Posttest(X_1) and Pretest(Y_1)

DF:	*Mean X - Y:*	*Paired t value:*	*Prob. (1-tail):*
94	3.01	1.78	.0389

N= 95 Note: 2 cases deleted with missing values.

Table 2

Paired t-Test for the Non-treatment Group Writing Attitude Scale Scores: Posttest(X_1) and Pretest(Y_1)

DF:	*Mean X - Y:*	*Paired t value:*	*Prob. (1-tail):*
98	.17	.15	.4406

N=99 Note: 16 cases deleted with missing values.

Table 3

Unpaired t-Test for Group and Writing Attitude Scale Pretest Scores: Computer and Non-Treatment Groups

DF:	*Unpaired t Value:*	*Prob. (1-tail):*	*N=212*
210	-.19	.4241	

Group:	*Count:*	*Mean:*	*Std. Dev.:*	*Std. Error:*
computer	97	79.99	6.01	1.63
non-treat.	115	80.41	15.72	1.47

Table 4

Unpaired t-Test for Group and Writing Attitude Scale Posttest Scores: Computer and Non-Treatment Groups

DF:	*Unpaired t Value:*	*Prob. (1-tail):*	*N=194*
192	1.73	.043	

Group:	*Count:*	*Mean:*	*Std. Dev.:*	*Std. Error:*
computer	95	83.32	15.99	1.64
non-treat.	99	79.17	17.4	1.75

Additional analysis using a paired t-test revealed that there was no significant difference between pretest scores for treatment and non-treatment groups (Table 3). Therefore, it was unnecessary to conduct ANCOVA. Finally, differences between treatment and nontreatment posttest scores were analyzed using an unpaired t-test for independent samples. This showed that WAS posttest scores for the computer group were significantly higher than those in the non-treatment group (Table 4).

ATWCS.

Similar analyses of the ATWCS revealed that treatment group scores on the ATWCS improved significantly at the .05 confidence level (Table 5). Non-treatment group scores also improved at the .05 significance level (Table 6). This result was unexpected and will be discussed later. An unpaired t-test for independent samples indicated there was no significant difference between both groups' pretest scores. However, further analysis using an unpaired t-test indicated posttest ATWCS scores of the treatment group were higher than those of the non-treatment group at a .05 significance level (Table 7).

Table 5

Paired t-Test for the Computer Group Attitude Toward Writing with the Computer Scale Scores: Posttest(X_1) and Pretest(Y_1)

DF:	*Mean X - Y:*	*Paired t value:*	*Prob. (1-tail):*
94	2.36	3.55	.0003

N=95 Note: 2 cases deleted with missing values.

Table 6

Paired t-Test for the Non-treatment Group Attitude Toward Writing with the Computer Scale Scores: Posttest(X_1) and Pretest(Y_1)

DF:	*Mean X - Y:*	*Paired t value:*	*Prob. (1-tail):*
97	.94	1.82	.0355

N=98 Note: 17 cases deleted with missing values.

Table 7

Unpaired t-Test for Group and Attitude Towards Writing with the Computer Scale Posttest Scores

DF:	*Unpaired t Value:*	*Prob. (1-tail):*	*N=194*
192	2.82	.0052	

Group:	*Count:*	*Mean:*	*Std. Dev.:*	Std. Error:
computer	95	35.83	5.13	.53
non-treat.	99	33.63	5.72	.57

Correlations

Unpaired t-tests and Pearson product moment coefficients were used to analyze relationships and correlations at the .05 confidence level.

For the grade 12 average group, there was a significant relationship between gender and scores on the WAS. Females scored higher, which corroborated the results of previous studies. There was, however, no significant relationship between gender and scores on the ATWCS.

There were no significant relationships between scores on the WAS and the ATWCS; pretest scores on the WAS and unweighted GPA; and scores on the ATWCS and the number of courses taken requiring in-class use of computers.

Comparison with AP Group

The differences between pretest scores for the grade 12 treatment group and the AP group were analyzed by an unpaired t-test for independent samples. The AP group scores were significantly higher at a .05 confidence level. Therefore, ANOVA was conducted to compare the differences between the computer, non-treatment, and AP group WAS pretest scores. A Scheffe F-test and Fisher PLSD test were conducted because differences were found at the .05 significance level (Table 8). These tests showed significant differences between the AP group and both average grade 12 groups, but not between the grade 12 treatment and non-treatment groups. The AP result was expected and consistent with earlier research.

Program Implementation

Students in the study were homogenously grouped by ability in required English classes in the Florida Writing Enhancement Program; nine of eleven average sections were included, 4 in one teacher's computer treatment group and 5 in the non-treatment group, divided between one male and one female teacher. The remaining 2 sections received a different computer treatment and were excluded from the study in order to reduce variables. Permission to test was granted by the Director of Research, Evaluation, and Student Services for Sarasota County Schools; the Director of Secondary Education; the Supervisor of Instructional Technology; and the building principal.

Table 8

Analysis of Variance Table for Group and WAS Pretest Scores

Source:	*DF:*	*Sum Squares:*	*Mean Square:*	*F-test:*
Between groups	2	2116.82	1058.41	4.36
Within groups	231	56026.28	242.54	p =.0138
Total	233	58143.1		

Model II estimate of between component variance = 12.07

Comparison:	*Mean Diff.:*	*Fisher PLSD:*	*Scheffe F-test:*
computer vs. non-treat.	-.42	4.23	.02
computer vs. AP	-10.51	7.25*	4.08*
non-treat. vs. AP	-10.09	7.14*	3.88*

* $p \leq .05$

Students in the treatment group were trained to use the Media Center computer laboratory and required to write at least one draft and the final copy in the lab. Students were also required to use the spellcheck, thesaurus, and grammar check. Use of an outliner was optional although prewriting had to occur either at home or in the lab. Access to the lab was provided before and after class, but use outside class was optional. Many students, however, spent extra hours in the lab. The non-treatment groups received traditional writing instruction. The laboratory consisted of 28 networked Macintosh computers and 2 standalone computers. Primary software included MacWrite II (Claris), RightWriter (Que), and SmartWorks (GreatWorks, Symantec).

Discussion and Implications

Writing apprehension in the computer group was significantly lower after treatment; and, furthermore, it was significantly lower than the results in the non-treatment group which received traditional writing instruction. Thus, the results provided answers to the original questions: a practical instrument to evaluate writing instruction, and concrete statistical improvement. But there also were other important implications for education.

First, if we, as educators, believe that providing access to technology is necessary, then the results of the ATWCS also will concern us. Although there was a greater improvement in the treatment group, there was a significant improvement in attitude toward writing with the computer in both groups. The students in the computer group had significantly higher scores, but why did non-treatment scores increase? It was hypothesized that because more than half the senior classes were involved in some type of computer treatment (four in the study plus two others), students were aware of the program by word-of-mouth. Both labs were in prominent places on campus, one in the media center and the other across from the English office. In fact, several students indicated they transferred from non-treatment classes to treatment classes because of the computer program. It is also possible that student exposure to computers at home, at work, and at school by the time they are seniors influenced their responses. Whatever the reasons, the results indicate that experience improved attitude towards writing with computers and that the students who did not receive the treatment would have been receptive to it.

Another important finding was that only 2.06% of the subjects withdrew from the computer group while 13.91% withdrew from the non-treatment classes. Two students from the non-treatment group cited writing apprehension (inability to keep pace with assignments and fear of failure) (Daly, 1985; Daly & Miller, 1975a) and use of the computer as reasons for transfer to the treatment group. While this area requires further study, use of computers in writing instruction may help reduce the dropout rate.

The issue of gender also is important. Females scored higher on the WAS (Table 9); this corroborated previous research (Daly & Miller, 1975b), but there was no gender correlation with the ATWCS. What are the implications for schools? First, although males have been seen as dominant in technical areas involving computers, gender is not a factor in computer anxiety if experience is equal (Kay, 1989). It is possible that the average female Riverview senior had enough exposure to computers at home, work, or school to affect the results. The average Riverview senior reported taking 2.4 computer intensive courses. It is possible that this result would not be duplicated at lower grade levels or in other populations. It is recommended that incoming freshman, students at other high schools, and seventh grade middle school students be tested.

Kay (1989) suggested the necessity for computer access for females, and a recent study indicated that stereotypes begin early in childhood (Collis & Ollila, 1990). Providing computer

Table 9

Unpaired t-Test for Gender and Writing Attitude Scale Scores Pretest: Computer and Non-treatment Groups

DF:	*Unpaired t Value:*	*Prob. (1-tail):*	*N=212*
210	-3.03	.0014	

Group:	*Count:*	*Mean:*	*Std. Dev.:*	*Std. Error:*
male	110	77.11	14.06	1.34
female	102	83.57	16.96	1.68

Table 10

Comparison of Computer Treatment Group Pre and Posttest Scores on the WAS by Gender

Group	*WAS pre*	*Comp. pre(X)*	*Comp. post(Y)*	*Comp.(Y-X)*
male	77.11	78.98	82.13	3.15
female	83.31	81.31	84.88	3.57

writing instruction appears to be a successful way to provide such access. Furthermore, computer instruction is beneficial for males who also made significant gains despite greater initial writing apprehension (Table 10). Computer instruction may be an equalizing factor for both males and females, in writing apprehension and computer anxiety, respectively. Further research is needed, especially at earlier grade levels.

The study found no correlation between the ATWCS and the number of courses taken requiring in-class computer use for Riverview seniors. The students in this population may have had enough prior computer experience to eliminate it as a correlate. This correlate should be tested for different grade levels and populations. Again, further research is indicated.

This study supported Shaver's (1990) conclusion that the WAS and the ATWCS are independent and no significant interscale correlation exists. This indicates that writers at all levels of proficiency may benefit. Shaver reported that student interviews revealed both high and low achievers had positive attitudes toward using the computer for writing.

There was no correlation between unweighted GPA and the WAS. Writing apprehension is more likely to correlate with verbal-intensive skills such as the verbal SAT (Daly & Miller, 1975b). A student's GPA may be bolstered by subjects requiring other skills or a disproportionate number of non-academic classes. Nevertheless, it is interesting to note the AP group, which had significantly higher WAS scores than the other two groups, had an unweighted mean GPA of 3.45 compared to a mean of 2.4 for the other two groups.

The AP group results are consistent with research that indicates the highest achieving students have the lowest writing apprehension and the best writing attitude (Daly, 1985; Daly & Miller, 1975b). It appears that improving writing attitude will increase writing quality. This is consistent with current theory which suggests that student writing improves with practice (Rodrigues & Rodrigues, 1986). If writing attitude improves, practice will occur more frequently and wholeheartedly.

Several important questions arose. First, what about other grade levels? Similar results were obtained with a grade 10 class, but further studies with more classes, grade levels, and schools is indicated. Shaver (1990) validated use of the instruments for grades seven through twelve.

Second, will improvement be long-term? Analysis beyond the original study indicated results were sustained for a semester and throughout the year. But this raised other questions that require further investigation: Can computer writing instruction continue to yield improved results, or will students reach a plateau? What is the cumulative effect of continued computer instruction over several years? Will students whose writing attitude has improved significantly show other successes associated with low writing apprehension in the future?

The treatment group composed final writing exams in class with paper and pen in June 1992. Anecdotal comments and written evaluations by students indicated the degree to which computers became identified with writing attitude. Some representative comments were as follows:

1. " It's true you can't go back again. The computer makes writing so much easier."
2. I liked this class because I really learned how to use the computer."

On writing longhand:

3. Where's the spell check?"
4. Now I realize how much the computer has helped me!"

Recommendations

The following curriculum recommendations are suggested:

1. Use computers to teach composition. Computers reduce writing apprehension and are likely to improve writing quality when used effectively. Computers motivate students and may reduce dropout rates. Computer instruction may equalize gender differences by improving writing attitude for males and providing computer experience for females.
2. Integrate use of the computer into the writing curriculum. Successful programs use the computer as a tool to implement curriculum. Effective programs also utilize the motivational quality and strengths of technology.
3. Provide ongoing means for evaluation and modification of the computer writing program. The Writing Attitude Scale and the Attitude Toward Writing with the Computer Scale are practical instruments that provide meaningful feedback.
4. Encourage teacher networking and sharing. Successful writing programs can be replicated.
5. Offer teacher training to experienced teachers so they may integrate computer use into their methods. Make training mandatory for prospective English teachers.
6. Use computers to improve attitude towards writing with a computer. In a technology-oriented world which often requires word-processing and computer literacy, students benefit from experience gained in school.

References

Bridwell, L.S., Nancarrow, P.R. & Ross, D. (1984). The writing process and the writing machine: current research on word processors relevant to teaching of composition. In R. Beach & L.S. Bridwell (Eds.), *New Directions in Composition Research* (pp. 381-398). New York: Guilford.

Collis, B. & Ollila, L. (1990, fall). The effect of computer use on grade 1 children's stereotypes about reading writing, and computer use. *The Journal of Research and Development in Education*, pp. 14-20.

Daly, J.A. (1978). Writing apprehension and writing competency. *Journal of Education Research, 72*, 10-14.

Daly, J.A. (1985). Writing apprehension. In M. Rose (Ed.), *When a writer can't write* (pp. 43-81). New York: Guilford.

Daly, J.A. & Hailey, J.L. (1984). Putting the situation into writing research: state and disposition as parameters of writing apprehension. In R. Beach & L.S. Bridwell (Ed.), *New directions in Composition Research*.

Daly, J.A. & Miller, M.D. (1975a). The empirical development of an instrument to measure writing apprehension. *Research in the Teaching of English, 9*, 242-249.

Daly, J.A. & Miller, M.D. (1975b). Further studies on writing apprehension: SAT scores, success expectations, willingness to take advanced courses and sex differences. *Research in the Teaching of English, 9*, 250-256.

Davis, B.G., Scriven, M. & Thomas, S. (1987). *The evaluation of composition instruction* (2nd ed.). New York: Teachers College Press. Florida Department of Education (1990). *English curriculum framework, grades 10-12.*

Gordon Rule (1991). Florida State Board of Education Rule 6A-10.30. *Manatee Community College Catalog 1991-1992*. Bradenton, Florida.

Hawisher, G.E. (1988, April). *Research in computers and writing: findings and implications.* Paper presented at the Annual Meeting of the American Educational Research Association. New Orleans, Louisiana.

Hawisher, G.E. (1989). Research and recommendations for computers and composition. In G.E. Hawisher & C.L. Self (Eds.), *Critical perspectives on computers and composition instruction* (pp. 44-69). New York: Teachers College, Columbia University.

Hermann, A.W. (1990). Computers and writing research: shifting our "Governing Gaze." In H.H. Holdstein & C.L. Selfe (Eds.), *Computers and writng: theory, practice, research* (pp. 124-134). New York: The Modern Language Association of America.

Hermann, A.W. (1989). Computers in public schools: are we being realistic?" In G.E. Hawisher & C.L. Self (Eds.), *Critical perspectives on computers and composition instruction.* (pp. 106-125). New York: Teachers College, Columbia University.

Kay, R.H. (1989). Gender differences in computer attitudes, literacy, locus of control and commitment. *Journal of Research on Computing in Education, 21*, 307-316.

Rodrigues, D. & Rodrigues, R.J. (1986). *Teaching writing with a word processor: grades 7-13.* National Council of Teachers of English. Office of educational research and Improvement, U.S. Department of Education.

Schaeffer, E.M. (1987). *Teaching writing with a microcomputer.* Phi Delta Kappa Fastback 54. Bloomington, Indiana..

Schwartz, E. & Vockell, E. (1988). *The computer in the English curriculum.* Santa Criz, California: Mitchell Publishing.

Selfe, C.L., Rodrigues, D. & Oates, W. (Eds.). (1989). *Computers in English and the language arts: the challenge of teacher education.* Urbana, Illinois: National Council of Teachers of English.

Shaver, J.P. (1990, July). Reliability and validity of measures of attitudes toward writing and toward writing with the computer. *Written Communication, 7*, 375-395.

Appendix I

Writing Attitude Scale

Directions: Below are a series of statements about writing. There are no right or wrong answers to these statements. Please indicate the degree to which each statement applies to you by **circling** whether you (1) strongly disagree (SD), (2) disagree (D), (3) are uncertain (UN), (4) agree (A), or (5) strongly agree (SA) with the statement. While some of these statements may seem repetitious, take your time and be as honest as possible. Thank you for your cooperation.

		SD	D	UN	A	SA
1.	I avoid writing.	1	2	3	4	5
2.	I have no fear of my writing being evaluated.	1	2	3	4	5
3.	I look forward to writing down my ideas.	1	2	3	4	5
4.	I am afraid of writing essays when I know they will be evaluated.	1	2	3	4	5
5.	Taking a composition course is a very frightening experience.	1	2	3	4	5
6.	Handing in a composition makes me feel good.	1	2	3	4	5
7.	My mind seems to go blank when I start to work on a composition.	1	2	3	4	5
8.	Expressing ideas through writing seems to be a waste of time.	1	2	3	4	5
9.	I would enjoy submitting my writing to magazines for evaluation and publication.	1	2	3	4	5
10.	I like to write my ideas down.	1	2	3	4	5
11.	I feel confident in my ability to clearly express my ideas in writing.	1	2	3	4	5
12.	I like to have my friends read what I have written.	1	2	3	4	5
13.	I'm nervous about writing.	1	2	3	4	5
14.	People seem to enjoy what I write.	1	2	3	4	5
15.	I enjoy writing.	1	2	3	4	5
16.	I never seem to be able to clearly write down my ideas.	1	2	3	4	5
17.	Writing is a lot of fun.	1	2	3	4	5
18.	I expect to do poorly in composition classes even before I enter them.	1	2	3	4	5
19.	I like seeing my thoughts on paper.	1	2	3	4	5
20.	Discussing my writing with others is an enjoyable experience.	1	2	3	4	5
21.	I have a terrible time organizing my ideas in a composition course.	1	2	3	4	5
22.	When I hand in a composition I know I'm going to do poorly.	1	2	3	4	5
23.	It's easy for me to write good compositions.	1	2	3	4	5
24.	I don't think I write as well as most other people.	1	2	3	4	5
25.	I don't like my compositions to be evaluated.	1	2	3	4	5
26.	I'm no good at writing.	1	2	3	4	5

Attitude Toward Writing with the Computer Scale

Part II. Directions: Below are a series of statements about writing. There are no right or wrong answers to these statements. Please indicate the degree to which each statement applies to you by **circling** whether you (1) strongly disagree (SD), (2) disagree (D), (3) are uncertain (UN), (4) agree (A), or (5) strongly agree (SA) with the statement.

		SD	D	UN	A	SA
27.	Writing on a computer is much more fun than writing with pencil and paper.	1	2	3	4	5
28.	All students should do more writing on a computer.	1	2	3	4	5
29.	People who write on computers become better writers than they would otherwise.	1	2	3	4	5
30.	Using a computer to write just makes writing more difficult.	1	2	3	4	5
31.	The students in every composition class should have access to a computer to write on at school.	1	2	3	4	5
32.	A computer program is not likely to be of much help in revising a paper.	1	2	3	4	5

33. Students would learn more if they could do the writing assignments in all of their classes on a computer.	1	2	3	4	5
34. Learning to write on a computer is more trouble than it's worth.	1	2	3	4	5
35. Computer programs can be helpful in deciding how to improve a paper.	1	2	3	4	5

Survey Questions
Part III.
Please **circle** the answers to the following questions for survey purposes:

Grade level: 9 10 11 12

Gender: Male Female

Previous computer experience (Please **write in** the number):

How many courses have you taken since entering high school that require in-class use of the computer (including programming, business education, and English)? ______ ______

Please **write in** your actual GPA: ______

Projects (T3.10)
Software Applications

Attracting Students With Magnets

Thomas A. Akin, Steve Muise, Mike Lopotka, and Robert D. Williams
Edgewater High School
Orlando, FL

Abstract

Edgewater High School, the University of Central Florida, and numerous business and community partnerships have developed a unique magnet school program. The Engineering and Science Technology Magnet school is a cross disciplinary and multi level learning program designed for those students interested or talented in math and science wishing to explore career possibilities in these fields by participation in project oriented instruction. Students take the skills they would normally learn in a class and apply them to real world situations. The Water Sentry program helps the City of Orlando monitor the health of area lakes through elaborate testing and evaluation done by the students. A database of this information is maintained by the students so systems models can be created to anticipate or determine problems in the lakes. The "Space Bus" project allows students to design, build, and demonstrate working models of their choice in scientific areas. The students accompany the bus to various elementary schools, middle schools and community events to instruct and demonstrate to the audience uses of space technology in our daily living. The instructors and coordinators of these programs will give specific information about development of and implementation of similar programs.

Looking for the Fairy Godmother to Make the Magic Work

John Dufour
Mosan Preparatory School
Mt. Pleasant, SC

Abstract

Obtaining the funding for those special projects can be very difficult at times. It seems that in order to make that unique project successful, financial support needs to come from many areas. In our user group, Apple Educators, a Fairy Godmother helps to make the various projects possible. This godmother was the Apple Educators User Group Program. By sanctioning the group and providing the group with a variety of bits of information, the user group program gave the group an instrument to obtain grants.

By duplicating an already successful grant (except for project specifics), the group was able to obtain $30,000 in state grants. This amount also reflects 1/3 of all grant money allocated for the program that has been received by the group.

One of the positive points of this "McDonald's" approach of duplicating success was the excitement generated by the group to write more grants To Make The Magic. The Fairy Godmother has granted our wishes...and didn't give us the midnight deadline!

Image Processing in Secondary School Space Science

Patricia A. McClurg
University of Wyoming
Laramie, WI

Abstract

The recently funded (NASA) Planetary and Space Science Center (PASS) at the University of Wyoming is exploring appropriate uses of image processing in secondary school space science. Earth/ Space scientists collaborated with exemplary secondary teachers in an examination of images available via the remote sensing laboratory, UNIDATA weather/climate center, NASA CD-ROM/videodisc collections using available image processors.

Three resulting ideas were targeted for development and testing during the 1992-1993 year. One module deals with understanding the Electromagnetic spectrum. Application exercises include using information from Landsat's five spectral bands to locate minerals, detect fire damage, and to study patterns of changing land use.

Another module deals with weather patterns. After accessing, plotting, graphing and interpreting data obtained via UW's UNIDATA link, students apply their knowledge of weather patterns in specific exercises. Two data sets, meteorological data for the western United States and MetSat Data of the United States, are used in the culminating activity where students interpret and analyze conditions from information tracking a major cold front.

In a third module, concepts of digitization and resolution of images are introduced. Students use PASS digitizing cameras to take images of objects (including some images taken through a telescope) and manipulate them in the image processor. Finally, planetary images taken from NASA satellites are examined.

Building Support for the NBA (No Boys Allowed) Multimedia Team

Mary Van Dyke
Atchison School District USD 409
Atchison, KS

Abstract

What causes many of our most able females to say, "No thanks" to technology, math, and science? Adolescence is an especially critical time when females develop "herd mentality" and see these areas as male domains. In studies focusing on technology, females are a distinct minority when it comes to computer use.

Products from a national Computer Expert Project and continuing grants will be shared. The training model and strategies will be discussed for encouraging females in non-traditional careers. Participants will receive tips on grant writing, low-budget multimedia and telecommunications projects, and K-12 educational technology user group information will be available.

Projects (T3.11)
Multimedia

MultiMedia Made Easy!

Forest Barbieri
Educational Resources
Elgin, IL

Abstract

Educational Resources, America's largest supplier of educational technology to schools, will demonstrate the utilization of MultiMedia to enrich the learning process.

This session includes an introduction to MultiMedia, a description of the components of MultiMedia, the "How To's" of Multimedia (capturing live, still, and video images; CD-ROM and projection devices; and much, much more!), and some strategies for integrating MultiMedia into your classroom curriculum.

EcoGuide: An Interdisciplinary, Multimedia Approach to Environmental Education

Elizabeth Carlson
Canton, MI

Abstract

EcoGuide is a new type of software tool for classroom use by teachers and students. Teachers can use *EcoGuide* to address instructional goals at the middle school level in environmental education, mathematics, technology, social studies, and language arts. Several educational principles underlie the approach taken in *EcoGuide*. These are: collaboration between teachers and students, cooperative learning among students, authentic work, active learning/adventuresome teaching, and construction of knowledge. *EcoGuide* supports those ideas teachers believe to be important in classrooms. In fact, staff development activities for *EcoGuide* begin by asking teachers to identify their core educational beliefs and then to examine *EcoGuide* to see how it can support their classroom activities.

EcoGuide has four sections that represent phases in a process of scientific inquiry: Planner, Investigator, Researcher, and Presenter. Used separately or together, these sections help students create and implement projects. The program provides support for these processes by: asking guiding questions, providing information, modeling an organizational process, and identifying decision points. Because *EcoGuide* is *HyperCard* based, it is relatively easy for teachers and students to modify the program to suit local situations and needs, and to reflect teachers' and students' contributions.

Computer Literacy for the 90s: A Multienvironment Multimedia Event!

Susan A. Garrett and Dolores Pusins
Hillsborough Community College
Tampa, FL

Abstract

This session focuses on the redesign of the Introduction/Literacy course being taught on higher education campuses. Its purpose is to design and present a model for incorporating multimedia technology into the presentation of information in beginning level computer information courses. Information that has historically been presented through lecture, demonstration, and use of overheads and other visual aids will now be presented in a much more dynamic, high-tech manner enhanced by hands-on activities in lab settings.

Since this is designed to span both the Macintosh based environment and the DOS based environment, we will use both types of equipment and software (such as MacroMind Director and Windows Player) for the presentation.

Multimedia incorporates text, graphics, animation, audio, and video, and can be a most effective tool for enhancing the learning environment in that these techniques bring the content to life more powerfully than other types of presentation software or, certainly, more so than traditional techniques. Simulation and prototypes can provide visualization of complex processes or concepts with interactive capabilities allowing for concrete learning. Presentations, once created, may be recorded onto videotape to be distributed inexpensively to other users.

It is our intent to develop a number of module(s) to assist in presenting information to students enrolled in the introductory courses in such a manner as to enrich their learning, as well as enhance our marketing efforts to increase program enrollment. We feel that the excitement generated through well-designed multimedia presentations will help us achieve those goals.

IBM Computer Camp for Kids

Julie Wallace
Kingsville Independent School District
Kingsville, TX

Abstract

Research is proving that computers can be used effectively with young children. Participants ranging in age from 4 to 8 years participate in this exciting event. High School student volunteers assist camp participants as necessary. A nominal fee is charged each participant, and the money is donated to student activity funds.

Students are introduced to word processing, graphics, multimedia, and telecommunications using the IBM Educational LAN Software package. The EdLAN package includes Microsoft Works, Express Publishing, Linkway (multimedia), and the ICLAS pop-up menu.

Computer camp activities reinforce writing, keyboarding and motor skills. Student communication skills through network telecommunications is especially exciting. Student artistic abilities are effectively demonstrated through the use of Linkway Paint program.

Student/teacher participants in the camp were surprised to discover that **it is not the software package that is or is not appropriate for early childhood, rather it is the activity being conducted.**

Computer Camp activities can play an important part in young children's interaction with computers and other technology. Most importantly it can provide a way to explore traditional curriculum areas in a totally new light.

Projects (T3.12)
Networking / Telecommunications

Presentation Magic—A Local Area Network Teaching Laboratory

Robert N. Cook
University of Southern Colorado
Pueblo, CO

Abstract

How can a local area network enhance your presentations of software and educational materials? Besides the Novell NetWare network operating system and a local area network of personal computers, the other essential ingredient is the Intel LANSchool software. Using LANSchool the instructor can broadcast his/her computer screen to the screens on all of the student computers on the LAN. The students' login scripts that execute when they attach to the network run the "student" software automatically. All the students have to do is turn on the computers and the first screen they see is the screen from the instructor's computer. Perhaps even more useful than broadcasting the instructor's screen, any screen from any student computer can be broadcast by the professor to all the other students. If a student has a "what if" or "what is this" question during class or during a lab session, the instructor can show this screen to all the other students as well. An additional tool available to the instructor is a mouse driven on-screen pointer.

This laboratory is supported in part by the National Science Foundation Instrumentation and Laboratory Improvement Program (NSF ILI Grant USE 9151447 91/94.)

Networking: Is It Worth It?

Larry J. McHaney
McCullough High School
The Woodlands, TX

Abstract

If your school or school district is considering networking your personal computers together, you have probably been confronted with the following questions. What should a network be able to do? What kind of network do we need for our situation? Which network operation system should we choose? Where can I get factual, unbiased information? What will it do for students, teachers, administration and staff? How much will it cost initially and how much to manage and maintain? Is it worth the cost?

We at McCullough High School have recently set out to answer these questions for our own school. This presentation will help the participants clarify networking issues as we discuss the answers that we found to these important questions. We will also help participants develop strategies to evaluate networking solutions in their particular settings as we discuss the features, philosophies, advantages and disadvantages of various types of network operating systems.

Implementing the Internet in the Elementary Classroom

Randy Sachter
Boulder Valley School District
Nederland, CO

Abstract

The Boulder Valley Schools District, based in Boulder, Colorado, has been awarded funding from the National Science Foundation to pilot a unique project. The goal of this project is to teach students and teachers alike to utilize Internet as a tool to enhance the existing K-12 curriculum.

I will give an overview of the various projects I have developed involving Internet at the elementary level, highlight the successes, and give warnings of potential problems. The robotics unit is one project example. Teams of students designed robots to perform specific jobs in space. These are the same tasks being worked on by N.A.S.A. scientists. Using LEGO LOGO, students program the robots and operate them. A mentorship was established through Internet between the robotics students and University of Colorado scientists working on similar problems. The grand finale was a field trip to the university's robotics lab to meet our telementors and share our robotics inventions. Other project topics include weather, oceanography, research and long-distance communication. Handouts of lesson plans will be available.

Projects (T3.13)
Special Populations

A Library Computer Lab With Curriculum and Teacher-Productivity Software

Dorris Collmorgen and Mary Goodwin
Lufkin Independent School District
Lufkin, TX

Abstract

The objective of this session is to show how a library computer lab equipped with EdLAN and curriculum software provides the following:

- Easy access to student courseware for remediation, reinforcement and enrichment
- Savings on software purchases
- Efficient class management programs for teachers—Microsoft Works, Grade2 and Excelsior Quiz
- Lab for teachers to schedule classes
- Writing lab for language arts classes

A lab of this type has been in existence for the past five years in Lufkin, a 5A high school in East Texas with 1700 students. It is extremely popular with students and faculty, and has provided computer access to every student and faculty member on campus.

The lab was set up with departmental classes and generic user ID's for each of the different departments of the school. This provided for easy network maintenance.

This presentation shows how one lab can provide computer access to a wide variety of users.

Chapter 1 Computerized: By All Means!

Jean Reynolds
Jean Cashion Consulting
Sanford, NC

Charles T. Gardner
Cumberland County Schools
Fayetteville, NC

Abstract

What do an OMR Scanner, Capture (a customized software program), dBase, and Scansurvey have in common? Reducing the paper work in your Chapter 1 program!! There couldn't be an easier way to handle your Chapter 1 evaluation and reports. Gains in NCE scores, sustained gains, eligibility lists, and more are right at your fingertips. The data can be scanned and reports generated with ease. Data can be analyzed to clearly confirm the efficiency of your Chapter 1 program. What a wonderful way to monitor student progress and keep track of student movement. You are not limited by grade level or program area which provides flexibility for any Chapter 1 program. Chapter 1 has advanced to the front through the use of technology. This technological trend has proven to be very effective when the scan applications are combined with dBase to provide unlimited access to the data. Parent surveys can be generated with the Scansurvey program, then scanned and results tabulated in various formats for your choosing. Monitoring your Parent Involvement Program couldn't be easier. What better way to reduce paper work than to make use of a Scanner, Capture, and Scansurvey. Whether working on state reports, research information, or preparing for a board meeting, having compiled school data at the Central Office makes your work much easier. This project is not limited by grade level or Chapter 1 project. Scan sheets can be customized to meet the changing needs of Chapter 1 and updates made to the Capture program. What a cost effective approach to the administrative tasks of Chapter 1!

The Computer Clubhouse: A New Model for Afterschool Centers

Natalie Rusk
The Computer Museum
Boston, MA

Abstract

The Computer Museum in Boston is developing The Computer Clubhouse, a new informal learning center targeted to serve youth from underserved communities. In The Computer Clubhouse, youth, ages 10 to 16, are able to use computers to work on projects related to their interests, concerns, and experience.

The rich environment of The Computer Clubhouse combines ingredients of an artist's studio, biology laboratory, television newsroom, architects' office, and a robotics workshop. Participants pursue projects in a variety of cutting-edge computer application areas: scientific simulations, electronic publishing, computer-controlled devices, computer game design, electronic music, and "virtual reality" design. Professionals and students from diverse fields and cultural backgrounds serve as Mentors, helping participating youth design their own computer-based projects. Mentors are genuine participants in the learning environment, creating their own projects and learning from others—as well as sharing their skills.

Natalie Rusk, Director of Education at The Computer Museum, will give an overview of this new program and discuss challenges related to broader issues in educational reform, including making use of community resources, the computer as a tool for construction, and the role of mentors in a learning environment.

Consumer Reports in Computer Applications Class

Donna L. Spatz
Antietam School District
Reading, PA

Abstract

This project addresses two needs at one time. The first is to raise the computer applications class from a "skills" class in which the machine is the focus of instruction to one in which the students' focus is now on the consumer issues. The second need is to fill a gap in the current curriculum to address *specific* consumer issues.

Using the computer to analyze current consumer issues is an exciting and dynamic way for students to become informed consumers and at the same time develop their computer skills. The *Consumer Reports* Classroom Program provides students with an eight issue subscription to *Consumer Reports* along with teacher support materials. The information in each issue is perfect for projects using the computer's spreadsheet, data base, word processor, HyperCard, and research tools.

Examples of fascinating topics developed in an open-ended manner with no single right answer will be presented. These *Consumer Reports* projects are interdisciplinary by their very nature. Student critical thinking skills are challenged with meaningful and timely topics. The results for the students are that they are able to use current computer skills for practical applications and that they are becoming consumers who will be able to make reasonable decisions about products and services.

Projects (T3.14)
Software Applications

Celebrating the Magic of Technology in the Writing Classroom

Karla Burkholder
Technology Consultant
Corinth, TX

Abstract

This presentation focuses on stimulating paradigm shifts from traditional teaching methods to innovative approaches incorporating collaboration, critical thinking, as well as current emerging computer technology.

Based on seven years experience developing a progressive program in the Plano Independent School District in Plano, Texas, the speakers present suggestions, insights, and models to colleagues concerning:

- management and scheduling of a computing writing lab
- instructional capabilities of word processing
- alternative methods of approaching literature and composition
- redefinition of the teacher's role in the classroom
- redefinition of the student's role in the classroom
- definition of the computer's role as a learning facilitator
- integration of the computer into the writing curriculum
- an integrated literature and composition unit
- a unit template

Speaker 1: How Infinite in Flexibility (or Am I Losing my Faculties?): Technology in the Writing Classroom

This discussion focuses on the shift from teacher-centered instruction to student-centered learning. The speaker highlights the logistics of sharing computers/lab space and the instructional capabilities of word processing and other types of software.

Speaker 2: How Infinite in Capability: Celebrating the Teacher Manager

The audience benefits from the presentation of a model unit which outlines alternative methods of approaching literature and composition. This unit illustrates the redefinition of the student's and teacher's roles in the modern classroom. The student emerges as an active participant in the teaching and learning while the teacher acts as the manager and mentor. The computer functions as a learning facilitator in this student-center classroom

Speaker 3: How Infinite in Creativity: Celebrating the Effective Teacher

The speaker offers the audience a model unit template which can be adapted by teachers for use in their classrooms. Unit sequence, varied activities, higher level questioning strategies, and collaborative assignments will be suggested as appropriate.

Home Grown Primary Language Arts Labs

Mathew M. Maurer
Butler University
Indianapolis, IN

Lynn Noel
William McKinley Elementary School
Greenfield, IN

David Spencer
Otis E. Brown Elementary School
Indianapolis, IN

Abstract

Students at William McKinley Elementary School #39 were entering first grade with markedly deficient skill in language arts. A solution to this problem was proposed within the building by the staff involved. The first grade team proposed the establishment of a first grade phonics lab. By using a lab approach the students have phonic skills introduced using different learning styles along with a consistent teaching approach. The process of establishing the lab was very successful and the lab itself has been shown to successfully address the identified problems.

Critical Thinking with Technology: Insight from Action Research

Judi Repman, et al.
Texas Tech University
Lubbock, TX

Abstract

Action research presents a model which can be summarized as "do what I study, study what I do". Designed to empower teachers to take control of their classrooms, the majority of action research has been done to support instruction in reading and writing. Through a process of formulating research questions based on actual classroom needs, the collection and analysis of a variety of data, reflection on results, and changes in practice, action research seems to be an excellent model for teachers interested in using technology to create environments where students can engage in critical thinking and problem solving.

In a graduate level class on critical thinking and problem solving with technology, students were required to develop and carry out an action research project. The projects were conducted in a variety of settings (early elementary to adult education) and across content areas. Each project was also framed by the research literature, as well as by additional literature appropriate for students at different levels of development. The presentation will focus on what was learned about creating technologically-enhanced learning environments for critical thinking and problem solving. Presenters will also reflect on how engaging in an action research project changed their view of teaching and learning with technology.

Posters (T3.15)
Technology in the Curriculum

INTEGRATE the Magic of Technology: PUBLISH an Elementary School Newspaper
Estelle Bentzen
Fairglen Elementary School
Cocoa, FL

Elementary Students Producing Magazines Using Aldus PageMaker
Kathleen Huggard-McKinney
Tropical Elementary School
Cocoa Beach, FL

Getting Started: Making the Multimedia Leap
Annette Lamb
University of Toledo
Toledo, OH

Multimedia and the Development of Literary Understanding: A Survey of Existing Applications
Carla Meskill and Karen Swan
State University of New York at Albany
Albany, NY

Video Manipulatives for Mathematics
Margo Nanny
Corte Madera, CA

Spotlight Sessions (T4.1)

Instructional Technology in NASDC Proposals

Henry Olds
BBN
Cambridge, MA

Abstract

Abstract not available at press time

Spotlight Sessions (T4.2)

Creating Mother-Tongue Literacy With The Computer: Make It Happen In Your Classroom

Bill Peet and Libby Peet
Jackson, TN

Abstract

Children teach themselves their mother tongue (English, here) by about age three or four. They accomplish this feat without the aid of lessons and curriculum, and they are in charge. They try the language out, to ask for food, love, and information, and get quick feedback from those who love them. Pretty soon they have figured out how the spoken language works. They have invented their own version of their mother-tongue.

The best of the talking word processors, picture-story writers, and interactive fiction software offers a compelling opportunity to assist children in learning to read and write the same way, by using the written language to explore things that are interesting to them, with instant feedback from the computer, peers, and mentors — auditory, visual, tactile, and SOCIAL. This presentation shows professionals and parents alike what has happened when we have set up a seamless strand of literacy acquisition for non-readers, with computers, appropriate software, an enabling, interest-assessing, and interest-driving process.

We will be presenting videos of children using various software packages in different stages of their own seamless process of literary acquisition. We will also demonstrate teaching strategies for an interest-driven classroom, using some of the best software we have discovered.

Society Sessions (T4.3)

Methods for Teaching & Understanding of Computing for High School Teachers: Part II

Institute of Electrical and Electronic Engineers (IEEE)
Ez Nahouraii, Panel Chair
Industry Education Consulting
Los Gatos, CA

This session is designed for High School Computer, Mathematics & Science Teachers, with the following objectives:

- To remove the mystery about computers
- To show how computers can be an aid to instruction
- To describe algorithms & how they are developed
- And to show examples of how to use computers to explore Mathematics & Science

It is presented by university professors, with the goals of developing an interest in computer science and engineering studies. It will also provide an opportunity for teachers to enhance their knowledge of computer science and engineering through the following brief non-technical presentations :

- Problem Solving & Algorithm Construction
- Anatomy of Computers
- Operating Systems
- Languages & Compilers
- Application & Examples in Mathematics & Science

This presentation is the second of a two-part series (see Society Session T3.6).

Panelists:

Michael Mulder, S. Landry, and Bradd Clark
University of Southwestern Louisiana
Lafayette, LA

Y. Patt
University of Michigan
Ann Arbor, MI

Society Sessions (T4.4)

Supporting New Ways of Teaching and Learning With Technology-Enhanced Classrooms

ISTE Special Interest Group for Technology Coordinators (ISTE / SIGTC)
Shelia Cory
Chapel Hill-Carrboro City Schools
Chapel Hill, NC

John Newsom
Bellevue Schools
Bellevue, WA

Abstract

This session will present a philosophical position on the role of technology in supporting a hands-on, project-oriented approach to education, and the details of two successful district-supported implementations in districts where site-based decision-making is practiced. Issues of policy-development, planning, staff development, and evaluation will be highlighted. Details of implementation will be shared, including issues of curriculum, instruction, technology use, and assessment. The role of the Instructional Technology Coordinator will be highlighted.

Society Sessions (T4.5)

Restructuring Science Through Technology

ISTE Special Interest Group for Technology Coordinators (ISTE / SIGTC)
Harry Tuttle, Panel Chair
Ithaca City School District
Ithaca, NY

Chris Dowd
Apple Computer, Inc.
Pittsford, NY

Abstract

Technology has been a major catalyst for science teachers and their students to restructure their classes! Science learning changes from a teacher delivery, "classical" experiment, and limited technology environment to a cooperative learning, open-ended experiment, and technology-enriched environment when teachers change their paradigms about what students are to learn and how they are to learn it. Student groups use computer networks to exchange ideas about their learning and to contribute their part of class experiments. See a videotape of a restructured science class! These techniquests for restructuring science can be applied to other disciplines.

Paper (T4.6a)

Using Student Experience to Guide Curriculum in Introductory Computing

Gerald E. Gau and Sandra Madison
University of Wisconsin at Stevens Point

Abstract

For the past four semesters students enrolling in Introduction to Computing at the University of Wisconsin-Stevens Point have been given a survey designed to assess their experience with productivity software. It was thought that the number of students coming to campus with a good personal productivity software background was increasing. Since a major part of the introductory computing course dealt with productivity software, the focus of the course might have to change. The survey results indicated that many students, in most cases more than 70%, rated their skill levels with productivity software as "Below Average" or "None." Given these results, the decision was made to continue the focus on productivity software. But since the campus computing environment was shifting to a Windows platform, both DOS and Windows software would be examined in the course.

Introduction

Since January of 1991 we have been surveying the computing experience students bring to the introductory computing course at the University of Wisconsin-Stevens Point (UWSP). The survey information has been used to help determine changing needs. The course is designed to develop an awareness of the computing resources available to students and provide "hands-on" experience with some of the resources. What follows is a description of our computing environment, a discussion of the survey, and a description of changes made to the introductory computing course.

The Computing Environment UWSP is one of 13 four year campuses in the University of Wisconsin System with an enrollment in the vicinity of 8500. The university has a student network of more than 325 computers accessed in computing labs located in academic buildings and dormitories. Most of the computers are IBM compatibles but there is one stand alone network of Macintoshes and a few Apple IIs. Students may also link their own IBM compatible computer to the student network from their dormitory rooms. All faculty have computers linked to the network as well.

The software available on the network falls into three broad categories: personal productivity software, utility software, and software provided by departments. The productivity software includes applications such as Word 5.5, Word for Windows, Quattro Pro, Paradox 4.0, PowerPoint, and others. Each of the major productivity applications is available in both DOS and Windows versions. The utility software includes applications such as electronic mail, hard disk managers, and terminal emulators. Most academic departments have a menu pick on the network under which applications pertinent to the particular area may be accessed. For example, the Math Education menu pick provides access to Mathematics Exploration Toolkit, Geometric Supposer, and other mathematics education software.

In addition to providing access to software, the network also gives students access to the library on-line catalogs at UWSP, UW-Milwaukee, and UW-Madison; course registration information such as the timetable of courses and seat availability for all courses listed; and other information of this nature. By the end of the Fall 92 semester student electronic mail should be available. The network also has a share directory which instructors use to distribute course information and assignments electronically.

Discussion

The introductory computing course is a service course which is designed to develop computing skill in basic productivity tools and awareness of other UWSP computing resources. It is required by some majors, but most students report in a paper they write at the beginning of the semester that they enroll out of a desire to improve their computing skills. Many also expressed the belief that computing skills will be necessary for most jobs.

After declining in the late 1980s, enrollments have been going up gradually these past four semesters. This semester (Fall 92) the number of registered students rose sharply to 367. The increased enrollment may be due to the fact that the campus is moving from DOS based software to a Windows 3.1 environment. But since 51.5% of students surveyed this semester were freshmen, this semester's increase is more likely due to a lack of computer experience at the high school level. Even discounting the large increase this semester, the trend for the past four semesters has been upward.

Because of declining introductory computing course enrollments in the late 1980s, we decided in 1991 to use a survey to help assess the computing experience students had upon entering the course. (See Appendix A for the survey form.) Our belief was that student needs had changed and consequently there might no longer be the need for the kind of introductory computing course we offered. Specifically, we suspected that the number of students coming to campus with a good personal productivity software background was increasing. Since a major part of the course dealt with productivity software, the focus of the course might have to change. So, the first part of the survey focused on productivity software and asked students to rate their capability with software tools such as the word processor, spreadsheet, database and desktop publisher. The middle part of the survey assessed background in computing languages and experience with DOS. The last question asked students how many years they had used a computer.

Much to our surprise, 70% of the students rated their skill level at "Below Average" or "None" in all areas surveyed except word processing. In the word processing area, the percentage was not as high but the results were equally surprising with 40-58% indicating below average or no experience We had assumed that almost all students used word processors to do writing assignments. Evidently this is not the case. The fact that 29-40% of the students reported less than one year of computing experience was also somewhat unexpected. We had believed that virtually all students had some computing experience. Apparently most do, but a sizable number have little computing experience and some have none. It is also interesting to observe that in the programming language area, 45-50% of the students report some experience with BASIC. We thought that with the increasing availability of productivity software in the high school, fewer students would have been exposed to BASIC. While this may be true, the survey results suggest that quite a few students worked with BASIC as well.

Given the survey results, we decided to continue to emphasize productivity tools in the introductory course. Since over 70% of the students rated their skill level at "Below Average" or "None" in all of the areas surveyed except word processing, there remains a clear need for a course that introduces students to productivity tools. However since our computing environment is changing to Windows, we decided to shift the emphasis from DOS to both DOS and Windows productivity tools. Where possible we will use DOS tools that have a user interface similar to the Windows graphical user interface. This semester (Fall 92) is our first attempt at doing both DOS and Windows applications. Since only DOS applications were used in the past, this represents a substantial change in both content and quantity. Table 1 lists the major topics we plan to cover and the software associated with each topic. Since Introduction to Computing is only a two credit course, we expect that not everything will be accomplished as planned. If topics have to be reduced in scope, we will likely eliminate some of the software from the I/O Secondary Storage topic. It is our intention to give students the option of completing assignments with either DOS or Windows software.

The survey results are presented in Table 2. Three sections of the introductory computing course were taught each of the four semesters. The survey, however, was given in only two of the three sections the first three semesters and in all three the last semester. It was administered on the first day of class. The discrepancy between the number surveyed and the number registered is due to the fact that some registered students did not attend the first class while some students added the course on the first day the class met. Under the "Class" category, "Specials" are students not in a degree program. We did not include items 17-19 in the survey until the Fall 92 semester. "NA" means not available.

Summary

For the past four semesters students enrolling in Introduction to Computing at the University of Wisconsin-Stevens Point have been given a survey designed to assess their computing background. The results suggest that many students, in most cases more than 70%, rate their skill levels with computing productivity software as "Below Average" or "None." Given these results, the introductory computing course will continue to focus on productivity software. But since the campus computing environment is shifting to a Windows platform, both DOS and Windows software will be examined in the course.

Table 1. Introductory Computing Topics

Topic	*DOS Software*	*Windows Software*
The UWSP Computing Environment	QFiler (a hard disk manager)	Windows 3.1
Word Processing	Word 5.5	Windows Write
The CPU	A processor simulator	Windows Calculator: decimal to binary to hexadecimal
I/O and Secondary Storage	PrintShop On-Line Card Catalog Wilson Databases	Windows Paintbrush Macintosh: ThunderScan
Operating Systems	DOS commands DOS 5.0 DOSSHELL	Windows File Manager
Spreadsheet	Quattro Pro	Quattro Pro for Windows
Desktop Publishing	First Publisher	Word 2.0 for Windows
Database	Paradox 4.0	Windows Cardfile Paradox for Windows
Data Communications	AT&T E-mail	AT&T E-mail

Table 2: Survey Results

	January 1991	*September 1991*	*January 1992*	*September 1992*
Number Registered	130 (2 classes)	145 (2 classes)	156 (2 classes)	367 (3 classes)
Freshman	41.5%	33.8%	41.7%	51.5%
Sophomore	27.7%	25.5%	37.2%	25.6%
Junior	18.5%	24.8%	10.9%	12.3%
Senior	11.5%	12.4%	8.3%	7.6%
Special	0.7%	3.4%	1.9%	3.0%
Male/Female				
Male	74.4%	45.5%	60.3%	56.1%
Female	25.5%	54.5%	39.7%	43.9%
Number Surveyed	120 (2 classes)	133 (2 classes)	164 (2 classes)	332 (3 classes)
Word Processing				
Advanced	6.0%	8.3%	8.5%	10.5%
Average	35.9%	41.7%	51.2%	47.6%
Below Average	35.9%	30.3%	26.2%	23.5%
None	22.2%	19.7%	14.0%	18.4%
Spreadsheet				
Advanced	2.6%	3.1%	0.6%	3.6%
Average	12.0%	16.9%	23.9%	21.1%
Below Average	27.4%	28.5%	33.1%	26.5%
None	58.1%	51.5%	42.3%	48.5%

Table 2. Survey Results continued

	January 1991	*September 1991*	*January 1992*	*September 1992*
Number Surveyed	120 (2 classes)	133 (2 classes)	164 (2 classes)	332 (3 classes)
Database				
Advanced	0.0%	0.8%	1.2%	2.1%
Average	12.0%	10.0%	12.9%	13.9%
Below Average	18.8%	29.2%	27.6%	28.3%
None	69.2%	60.0%	58.3%	55.4%
Desktop Publishing				
Advanced	0.0%	3.1%	1.2%	2.1%
Average	5.2%	5.4%	7.4%	6.9%
Below Average	15.5%	15.5%	14.1%	12.7%
None	79.3%	76.0%	77.3%	77.7%
Painting Program				
Advanced	0.0%	4.7%	0.6%	3.6%
Average	4.3%	4.7%	10.6%	6.6%
Below Average	12.0%	12.4%	13.1%	15.7%
None	83.8%	78.3%	75.6%	73.8%
Drawing Program				
Advanced	0.0%	5.3%	0.0%	4.2%
Average	7.7%	7.8%	13.7%	10.9%
Below Average	16.2%	14.0%	16.8%	19.6%
None	76.1%	72.9%	69.6%	65.3%
Sign Making Program				
Advanced	2.6%	7.0%	3.8%	3.9%
Average	10.3%	7.0%	11.3%	12.7%
Below Average	10.3%	16.3%	20.0%	16.0%
None	76.9%	69.8%	65.0%	67.2%
HyperCard Program				
Advanced	0.0%	0.8%	0.6%	0.6%
Average	0.9%	2.3%	0.0%	3.0%
Below Average	4.3%	7.0%	6.3%	6.3%
None	94.9%	89.9%	93.0%	89.5%
Scanning Software				
Advanced	0.0%	0.8%	0.6%	1.2%
Average	1.7%	3.9%	6.8%	2.7%
Below Average	12.8%	10.9%	13.0%	16.4%
None	85.5%	84.5%	79.6%	79.4%
Assembly Language				
Advanced	0.0%	0.8%	0.6%	0.3%
Average	3.4%	2.3%	1.2%	2.1%
Below Average	6.8%	8.5%	9.9%	9.1%
None	89.7%	88.4%	88.2%	88.2%
BASIC				
Advanced	2.6%	3.8%	3.7%	5.1%
Average	19.7%	18.5%	22.4%	17.8%
Below Average	26.5%	30.8%	29.2%	19.3%
None	51.3%	46.9%	44.7%	57.7%
C				
Advanced	0.0%	0.8%	NA	0.6%
Average	1.7%	0.0%	NA	1.8%
Below Average	3.4%	6.2%	NA	4.2%
None	94.9%	93.1%	NA	93.0%

Table 2. Survey Results continued

	January 1991	*September 1991*	*January 1992*	*September 1992*
COBOL				
Advanced	0.9%	0.8%	0.0%	0.3%
Average	1.7%	0.8%	0.6%	2.4%
Below Average	5.1%	5.4%	5.1%	6.9%
None	92.3%	93.0%	94.3%	90.0%
FORTRAN				
Advanced	0.0%	0.8%	0.0%	0.3%
Average	2.6%	3.1%	1.3%	2.4%
Below Average	5.1%	6.2%	3.8%	6.3%
None	92.3%	89.9%	94.9%	90.6%
Pascal				
Advanced	3.4%	0.8%	0.6%	1.5%
Average	6.8%	8.5%	6.9%	9.4%
Below Average	8.5%	10.1%	14.4%	10.6%
None	81.2%	80.6%	78.1%	78.2%
DOS				
Advanced	1.7%	3.1%	3.1%	4.5%
Average	12.0%	14.7%	18.8%	19.6%
Below Average	17.1%	23.3%	25.6%	18.4%
None	69.2%	58.9%	52.6%	57.5%
Macintosh Skill Level				
Advanced	NA	NA	NA	2.1%
Average	NA	NA	NA	18.1%
Below Average	NA	NA	NA	23.8%
None	NA	NA	NA	55.7%
PC/Compatible Skill Level				
Advanced	NA	NA	NA	3.3%
Average	NA	NA	NA	19.5%
Below Average	NA	NA	NA	24.0%
None	NA	NA	NA	53.2%
Windows Skill Level				
Advanced	NA	NA	1.9%	2.4%
Average	NA	NA	9.4%	16.2%
Below Average	NA	NA	18.8%	23.2%
None	NA	NA	70.0%	58.2%
Years of Computer Use				
5 or more	10.6%	11.0%	16.5%	15.0%
3 or 4	18.6%	22.0%	24.7%	24.3%
1 or 2	30.1%	29.1%	29.7%	29.9%
Less than 1	40.7%	37.8%	29.1%	30.8%

Appendix A
Computer Background Survey

Name ______________________ Section ______________________

Please circle/bubble the skill level that best describes your capability with each of the following. Write the name of the software package you have used to the right.

A = Advanced B = Average C = Below Average D = None

Type of Software	*Skill Level*				*Software Package*
Word Processing	A	B	C	D	
Spreadsheet	A	B	C	D	
Database	A	B	C	D	
Desktop Publishing	A	B	C	D	
Painting Program	A	B	C	D	
Drawing Program	A	B	C	D	
Sign Making Program	A	B	C	D	
HyperCard kind of Program	A	B	C	D	
Scanning Software	A	B	C	D	
Assembly Language	A	B	C	D	
BASIC	A	B	C	D	
C	A	B	C	D	
COBOL	A	B	C	D	
FORTRAN	A	B	C	D	
Pascal	A	B	C	D	
DOS	A	B	C	D	
Skill Level on a Macintosh	A	B	C	D	
Skill Level on PC/Compatible	A	B	C	D	
Skill Level with Windows	A	B	C	D	

How many years have you used a computer?

A 5 or more B 3 to 4 C 1 to 2 D less than 1

Paper (T4.6b)

Classroom Equipment for Instructional Enhancement of a Computer/Math Core Course

Chaya Gurwitz and Neomi Halpern
Brooklyn College of the City University of New York

Introduction

Core Studies 5 is a 3-hour, 3 -credit course entitled "Introduction to Mathematical Reasoning and Computer Programming." It was designed jointly by the Department of Mathematics and the Department of Computer and Information Science and is aimed at non-mathematics, non-computer science and, in general, non-science majors. The course introduces such students to mathematical concepts and reasoning and it provides them with hands-on programming experience to aid in understanding the nature and power of the modern computer. This course is required of all undergraduate students, with the exception of those who have taken more advanced courses in both mathematics and computer science.

This paper discusses a project under which the Core Studies 5 classrooms were re-equipped. The project was designed in order to improve the instructional quality of the course and give students experience with state-of-the-art computer equipment. Two classrooms designated for Core Studies 5 were equipped with video projectors hard-wired to computer workstation. Two additional rooms were set up as "computer classrooms" with students workstations connected through a local area network. Our choice of equipment was influenced by the requirements of the course and by budget constraints.

The initial results of this project have been encouraging. The instructors have been using the projectors and computers to illustrate many of the topics taught in the lectures. We feel that it is especially important for non-mathematics, non-computer science students to participate in such demonstrations in class and to become acquainted with modern technology in order to reduce their mathematics and computer science anxiety. Our hope is that this project will lead to still further enhancements in the instruction of this course.

Core Studies 5: A Computer/Math Core Course

Brooklyn College, one of the nine senior colleges of the City University of New York, is committed to providing the highest quality education to students of diverse ethnic, religious and economic backgrounds. There are currently 12,066 undergraduate students as well as 3,474 graduate students enrolled at Brooklyn College.

Beginning in 1981, all Brooklyn College undergraduate students have been required to complete a ten-course, 34 credit, core curriculum. The idea of a core curriculum evolved over a period of several years after long deliberations by the faculty on the question of what a college education should encompass. The faculty established the following five general guidelines or criteria for the individual courses:

1. Core courses are designated for nonspecialists and are suitable for nonmajors, but each is planned in such a way as to introduce material of fundamental and lasting significance. In this sense core courses are foundation studies.
2. Core courses aim at opening the mind, at broadening awareness and widening horizons rather than at specific career preparation. They aim at cultivating the intellect and imagination, at developing general skills rather than vocational skill. In the long run, such general skills constitute the best preparation for any career.
3. They offer both substantive knowledge and insight into the way knowledge is acquired. Emphasis varies, some courses stressing more the ways in which knowledge is acquired, others concentrating more on what is taken to be definitive human achievements.
4. Their purpose is to give the student a perspective, an overall view of a subject of branch of learning, and a substantial amount of essential information, which together with other core courses provide a solid background in the liberal arts and sciences.

Core Studies 5 is a 3-hour, 3-credit course entitled "Introduction to Mathematical Reasoning and Computer Programming." It was designed jointly by the Department of Mathematics and the Department of Computer and Information Science and is aimed at non-mathematics, non-computer science and, in general, non-science majors. The course introduces such students to mathematical concepts and reasoning and it provides them with hands-on programming experience to aid in understanding the nature and power of the modern computer. The two components of the course are reinforced when students are asked to write programs to illustrate the mathematical concepts that they have studied. The bulletin description of the course is included in the Appendix.

Core Studies 5 is a "first tier" core course and students are urged to take it during their freshman or lower sophomore year. The professors teaching "second tier" core courses and other upper level courses can expect their students to be familiar with the computer and exposed to mathematical concepts and can draw upon these skills in their classes.

This course is required of all undergraduate students, with the exception of those who have taken more advance courses in both mathematics and computer science. Many students who later become computer science or mathematics majors have their first exposure to their major field in Core Studies 5.

Core Studies 5 is offered each semester in the day and evening programs as well as during the summer. Currently there are 38 sections with approximately 1000 students scheduled per semester. The Core Studies 5 classrooms are in almost continuous use fro 8:00 A.M. to 9:30 P.M. daily.

The College offers strong support for its core curriculum. Most core courses are taught by full-time faculty members. Senior professors are very involved in designing, evaluating and teaching core courses. The chairmen and deputy chairmen of the mathematics and computer science departments have taught Core Studies 5. A peer tutoring service has been instituted for core courses. Students who perform well in Core Studies 5 often become peer tutors in subsequent years. An assigned tutor is available to each class for six hours a week. A drop-in tutoring service is available all day.

There are two coordinators for Core Studies 5—one from the computer science department and one fro the mathematics department. The coordinators usually serve for two years and obtain release time to enable them to devote much attention to the course. They chair the frequent staff meeting to discuss the course, help write the quasi-uniform final exam and prepare annual evaluations and reports.

The course is continuously evaluated by the faculty teaching the course, by the course coordinators, by the Department of Mathematics and the Department of Computer and Information Science faculties, by the students enrolled in the course, by peer tutors assigned to the course, by the college-wide Core Committee and by outside evaluators.

The Past: Obsolete Facilities

The two Core Studies 5 classrooms were each equipped with Kodak Data Show display devices attached to overhead projectors which allowed the instructor to work at the keyboard and project the results onto a screen. The start-up procedure for use of the projectors was long and cumbersome. The screens were difficult to see, even with the lights off, and impossible to see with the lights on (which the students need in order to take notes). The image was neither sharp nor clear at any time. They represented first generation PC display technology.

The Core Studies 5 laboratory room contained 20 Apple II computers. Many of the machines were out of order. Maintenance personnel claimed that it was extremely difficult to keep the computers running. The machines were obsolete and were subjected to heavy use by 800-1000 students a semester for 14 semesters, plus lighter usage during the summers.

Before 1988, Core Studies 5 students, did not, in general make use of the College's Academic Computing Center facilities since most sections of the course were taught with the use of Apple II computers. Secondly, while Core Studies 5 students could use the facilities in the computer Center, there was simply not enough equipment to support the extra 1000 students enrolled in Core Studies 5 above the load of Computer Science majors.

In a survey of student opinion regarding the core curriculum, over one-half of the students rated Core Studies 5 above average in value and interest. However, negative comments far exceeded the positive remarks regarding this course. One major complaint regarded the poor quality of lecture display. Faculty were perceived as having difficulty in presenting the material in a clear way because of the physical setup of the classrooms. The projectors used in the classrooms frequently broke down and were hard to see. In addition, students felt that they were unable to do more than get a first acquaintance with computers. Some pointed out that they would have like to have more opportunity to run programs on their own in class. A few students remarked that the technical equipment for the course was outdated. Annual reports fro the course coordinators and the Core Studies 5 faculty echoed these sentiments. Year after year, the faculty lamented to deplorable state of the equipment available for core Studies 5 and commented on the difficulties of teaching with insufficient technical support in the classroom.

The Present: Enhanced Instructional Environment

Recognition of the obsolete facilities for Core studies 5 led to the implementation of a project to upgrade the technology used for the course. This project was partially supported by the National Science Foundation, under its Instrumentation and Laboratory Improvement program. The Core Studies 5 classrooms and laboratory have been totally re-equipped, and a second computer classroom has been made available for Core Studies classes. The new equipment has greatly improved the instructional quality of the course and provides students experience with state-of-the-art computer equipment.

All sections of core Studies 5 now use up-to-date equipment in place of the outdated Apple II computers. Three classrooms in the instructional building are specifically designated for Core Studies 5, and a fourth classroom in the College's Academic computer Center, has also been designed for use by core Studies 5 classes. Two of the classrooms are traditional lecture rooms, but have been equipped with Electrohome video projectors hard-wired to personal computers. A third classroom—conveniently located across the hall fro the other two classrooms—has been set up as a "computer classroom" with 24 IBM-clone PS/2 workstations and a local area network. The allocation of this room is based on the needs of the different sections of the course and the preferences of the instructors. Some instructors utilize this room on a regular basis while others use it when they teach particular topics in the course. A second "computer classroom," located in the computer Center, has been equipped with 17 Apple Macintosh IIci workstations and a local area network, as well as an Electrohome color video projector. This classroom can be used by instructors who prefer the Macintosh user interface.

For laboratory work, the students use the College's Academic Computer Center, which is equipped with both IBM PS/2 and Apple Macintosh computers. In this lab, not only can students work on their programming assignments, but they can also access other software such as word processing and spreadsheet packages. Student aides in the lab help students with hardware difficulty, while peer tutors provide assistance with programming problems.

Equipment Choices

Display Equipment. In choosing display equipment, our concern was to provide high resolution graphics and 80-column text visible everywhere in a typical classroom. In addition, we were concerned with setting up a flexible environment, by purchasing equipment that can be upgraded in the future and that can be used with either IBM of Apple Macintosh computers. Finally, we were constrained to work within the budget allocated for the project.

We chose to install Elecrohome video projectors in the two traditional classrooms as well as in the Macintosh computer classroom. We did not have sufficient funds to purchase a projector of the IBM-clone computer classroom although we hope to be able to purchase one in the future. Projection equipment is less crucial for this classroom, since the students have workstations at their seats.

In each room, the video projector is connected to the instructor's workstation and projects onto a pull-down screen at the front of the classroom. The instructor is able to sit at the front of the room, facing the class, while he or she uses the keyboard. The brightness of the screens allows the projectors to be used with normal classroom lighting. These projectors can easily be upgraded to conform to new graphics standards.

In choosing these projectors, we also considered alternatives such as ceiling mounted monitors and liquid crystal display device. (LCDD's) for overhead projection. Our previous experience with Kodak Data Shows discouraged us from purchasing LCDD's, although they are cheaper. We had found that they are clumsy to use and do not produce a clean, sharp image. Fluorescent lighting in the classrooms can interfere with these projectors. The lights have to be turned off in order to view the screen, which interferes withe the lecture and makes it difficult for students to take notes. The start-up procedure for use of this type of equipment is cumbersome. Ceiling mounted monitors are a comparably-priced alternative to video projectors. However, the 30-inch screens are harder to view fro the back rows of the classroom and there is no upgrading capability.

Computer Classroom. The main computer classroom was equipped with 24 IBM-clone PS/2 Model 30 workstations. The workstations are connected to a network server and are ale to run BASIC and Turbo Pascal. An IBM-clone PS/2 Model 50 is used as the network server and as the instructor's workstation. There are also both a dot-matrix and a laser printer connected to the network. The second computer classroom contains 17 Apple Macintosh IIci workstation, a dot-matrix and a laser printer, as well as an Elecrohome color video projector.

The primary cost-cutting decision that was made in equipping these rooms was to purchase "clones" in place of IBM "brand-name" equipment. We found that, by using clones, approximately 50% more computers could be purchased at about 5/6 of the cost of using brand-name machines. Of course, this decision was made with the understanding that it involved some degree of risk. Fortunately, we have not experienced any difficulties with this equipment.

Use of the Equipment for Instruction

All sections of the course are now able to make use of computer demonstrations in the classroom. In the traditional classroom the instructor can use the computer and project the results onto the screen. In some cases, the instructor will hold the class in one of the computer classrooms, so that the students can use the computers on their own. Many instructors use both the projector in the regular classroom and the computer classroom during the course of the semester.

The computer classroom is used in various manners by different instructors. Some of the typical uses of the classroom are as:

- a classroom in which students can get "hands-on" experience with computers;
- a location for weekly workshop under the direction of the instructor, in conjunction with other regular lecture periods;
- a location for special review sessions before midterm or final exams;
- a setting or administering "computer exams" in which the students must use the computers to solve problems or edit programs;
- for tutorial workshops led either by the instructor, or by tutors hired by the instructor, to help students outside of class time;
- for intructors to hold office hours in proximity to the computer, rather then in their own offices.

In addition, since the computer classrooms are set up with a local area network, some instructors have provided programs and on-line tutorial which can be accessed by all students. The following is a partial listing of the programs that are available on the network in the IBM-clone classroom:

- Million—generates a large number of coin flips and demonstrates that the ratio of the number of heads to the total number of flips approaches .5.

- Norm-Std—converts a normal distribution with mean M and standard deviation V to the standard normal distribution which has mean 0 and standard deviation 1.
- Perfect—determines whether or not a given number is a "perfect number."
- Pi— approximates pi by a target shooting simulation.
- Prime—factors any number under 10,000.
- Quad—solves quadratic equations of the form ax2+bx+c=0 by using the quadratic formula.
- Rndrun—demonstrates the use of random numbers in examples taken fro dice and roulette simulation.
- Roul380—simulations 380 spins of a roulette wheel, and counts the number of times a specified number appears.
- Search—computer search of data line for the presence of a specific item.

Conclusion

Brooklyn College's core curriculum has attracted attention nationwide. With support from the Andrew W. Mellon Foundation over 60 colleges have sent observers to Brooklyn College to study the core curriculum firsthand. The core is seen as being in the forefront of a general trend of "going back to the basics." Core Studies 5 has especially aroused interest in the academic Community in its attempt to teach mathematics to non-science students and to ensure that all students are "computer literate." Much attention is currently focused on introducing computers into the mathematics curriculum. Most of the discussion centers around calculus and higher level course. Core Studies 5 introduces the use of the computer in teaching low-level introductory mathematics concepts in various areas. The course does not merely make use of available software for instructional purposes; students are taught to write computer programs and to test their mathematical results via the computer.

This project has provided an enhance instructional environment for the course. Instructors are able to use computer demonstrations in the course of their lectures; students are introduced to modern computers in the classroom, under the direct supervision of the instructor. It is especially beneficial for non-mathematics, non-computer science students to participate in such demonstrations in class and to become acquainted with modern technology in order to reduce their mathematics and computer science anxiety.

Appendix

Core Studies 5: Introduction to Mathematical Reasoning and Computer Science

3 hours; 3 credits

Mathematical reasoning, formal mathematical systems, algorithms, and problem-solving. Then nature of the computer and the use of computers in problem-solving. Introduction to computer programming.

(Not open to students who are enrolled in, or have completed, any course in Computer and Information Science or to students who have completed a Mathematics course numbered 3.20 or higher with a grade of C or higher.)

Prerequisite: A high school course in intermediate algebra or Course 2 of the New York State Sequential Mathematics Curriculum, or Mathematics 0.35 or 0.44 with a grade of at least C, or Mathematics 0.36 or 0.04, or the equivalent.

Rationale

This course develops students' abilities to reason precisely and to express and analyze real-world problems in mathematical terms. It provides opportunities for students to explore the powerful concepts of a mathematical proof and of an algorithm, and to learn a variety of formal methods and problem-solving strategies.

An understanding of the nature of a computer and of computer emerges. Students are given hands-on experience formulating solutions to problems, and writing and running simple computer programs to implement algorithms.

The course develops methods of reasoning that will be useful in other courses in the curriculum. It also reinforces connections between computer science and mathematics by applying the techniques and power of computing to solve mathematical problems, and by making concrete the notion of formalization, whether of a mathematical concept in a proof or of an algorithm in a program.

Paper (T4.6c)

Developing a Computer Architecture Course: Lessons Learned

Linda H. Rosenberg
Goucher College
Baltimore, Maryland

Abstract

Computer Architecture is an important area of Computer Science, however, it is often neglected in Computer Science curriculums, especially in small colleges. This paper discusses how a Computer Architecture course was successfully implemented, with very little funds. The course included lectures, constructing circuit simulations on the Macintosh, then laboratory experiments where students built components using various types of chips and logic circuits. The students' evaluations of the course conclude this paper.

Computer Architecture in the Computer Science Curriculum

In 1991 ACM/IEEE-CS Joint Curriculum Task Force issued *Computing Curricula 1991* that was summarized in the *Communications of the ACM*, June, 1991. In *Computing Curricula*, nine subjects are identified that comprise the Computer Science discipline: 1) Algorithms and Data Structures; 2) Architecture; 3) Artificial Intelligence and Robotics; 4) Database and Information Retrieval; 5) Human–Computer Communication; 6) Numerical and Symbolic Computation; 7) Operating Systems; 8) Programming Languages; 9) Software Methodology and Engineering.(Tucker, 1990) These are the same subjects identified in the report *Computing as a Discipline*. (Denning, 1988) While these subject areas cover the entire Computer Science discipline, each contain fundamental subjects that should be required in all undergraduate programs. In this curriculum, the graduates achieve a breadth of understanding across the entire discipline rather than just a few of its parts. (Eerkes, 1991) These guidelines are especially useful to small, independent colleges such as Goucher College in Maryland. By adopting this curriculum, these schools can offer a computer science major competitive with larger colleges and universities who also use this curriculum.

Within the architecture subject area, *Computing Curricula* identifies seven common requirements (knowledge units) for a total of 59 hours of instruction. The purpose of these requirements is to provide a platform of basic knowledge that is considered essential for all students. The knowledge units for architecture are: 1) Digital logic; 2) Digital systems; 3) Machine level representation of data; 4) Assembly level machine organization; 5) Memory system organization and architecture; 6) Interfacing and communication; and 7) Alternative architectures. Two knowledge units, Digital logic (2) and Interfacing and communication (6), should have closed laboratories associated with them. The labs, approximately 2–3 hours in length, should be scheduled, structured and consist of supervised assignments involving the use of computer hardware and software. (Tucker, 1990)

Incorporating a Computer Architecture Course

At Goucher College, the computer science curriculum is reviewed yearly to determine if the needs of the graduating students are being met. It recently was determined that the lack of a course in Computer Architecture hindered graduates taking the Graduate Record Exam (GRE) and applying to graduate programs in Computer Science. A survey done by ACM of 150 Masters Programs indicated that 25% of the programs require a Computer Architecture course for admission, 9% require Digital Systems, and 5% require Micro Computer Systems. (Eerkes, 1991)

Although Goucher is small, with an annual enrollment of approximately 1100 students, it is competitive. The Computer Science department decided that the Computer Science curriculum should be updated to include a course in Computer Architecture. This course would be required of all Computer Science majors, and should follow the guidelines as specified in *Computing Curricula 1991* as closely as possible. In order to place the Computer Architecture course in the curriculum, it had to replace an existing course. Since the course removed was three credits, the Computer Architecture could only be 3 credits, with no time allotted for a laboratory.

The first step in incorporating a Computer Architecture course into the curriculum was to find a professor and enter a course description in the catalog. Since I received a Masters of Engineering Science Degree many years ago, I was given the job, though I had not worked with hardware in years. The course was entitled *Computer Architecture* and the following description was entered into the course catalog:

> Design methodology at the register, processor, and memory levels. Fundamental concepts of digital logic and circuitry design.

A prerequisite of the Computer Organization and Assembly Language Programming course was stipulated since it covered the material in the knowledge units Machine level representation of data (3) and Assembly level machine organization (4).

The next step was to find a textbook that started at a very elementary level, assuming no prior knowledge of engineering principles. A few books met this specification and covered the necessary material, but one text also included laboratories associated with the material. This text, *Digital Design* by Mano, was selected since it started at a very basic level with logic gates and Boolean logic and functions and contained laboratory experiments corresponding to the material. (Mano, 1991)

Computer Architecture Lectures

The lectures included material from 7 of the 10 chapters, covering most of the material specified in the curriculum guidelines. The course started with a brief review of the binary number system and binary codes. The basic postulates of Boolean algebra were introduced, showing the correlation between Boolean expressions and their corresponding logic diagrams. All logic operations for two variables were investigated and the possible logic gates determined. Boolean expressions were mapped, tabulated and used to simplify digital circuits. Basic components such as adders and code converters were used to investigate formal procedures for analysis and design of combinational circuits. A brief time was spent on medium scale integrations circuits and programmable logic device components such as parallel adders, decoders and multiplexers. The semester concluded with clocked synchronous sequential circuits of flip–flops and sequential digital components such as registers and counters.

Computer Architecture Lab

After reading the Mano text, I came to two conclusions. First, the students needed to actually build the circuits. Theoretical knowledge was not sufficient for learning the material. Second, while I felt competent to teach the lecture material, I did not have the hardware expertise or experience to conduct the labs.

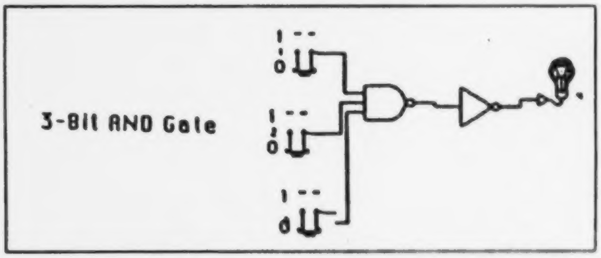
The first task was to develop labs when no funds had been allotted for this course. It was determined that $50 could be used from the departmental budget for supplies, and a complete design workstation was located. It included breadboards, a power supply and instrumentation such as a function generator, output for generating clock pulses and logic state indicators, almost everything that would be needed to do the labs. However, the cost was approximately $300 per piece. Back to the catalog. It was decided that all circuits built would be solderless for safety (mine and theirs). Solderless breadboards would work and were priced at about $4 for small ones. We also would need a power supply that started at about $50. Wire was fairly inexpensive if bought by the roll. We also would need a logic probe and pulser, available for about $40 in a multimeter. We still needed the chips, but at this point it was recognized that a meaningful lab experience could not be developed using this supply methodology—there simply were not enough funds available.

At this point I approached a friend who was attending college while working as a computer repair technician. He had extensive test equipment, power supplies, probes and wires, and the knowledge of how to use them. He agreed to help me design and run 4 laboratories, supplying the power supply and test equipment. I agreed to supply the breadboards, chips, material to be covered in the labs, and a letter of recommendation for him. Since there were only six students in the class, I broke them into two groups, and purchased two medium size breadboards and chips, wires and indicator lights (LED) as needed, for just about $50.

The second challenge was to find a time and place to hold the labs. A Biology professor, Janet Shambaugh, agreed that we could meet in her laboratory, where we would have the large lab tables. The class agreed on one hour in the afternoon, a time the technician and the lab room were available.

Since the students lacked knowledge in rudimentary engineering principles, before actually constructing circuits with chips and wires, we used a Freeware package call DigSim, a Digital Logic Simulator for the Macintosh. This package allowed students to learn digital logic and test their circuits. DigSim uses 16 elements including input switches, output light, inverters and flip–flops. The students were given an assignment to design and test three simple circuits in an open laboratory environment. An example of one simple circuit that could be built and tested using DigSim is shown in Figure 1.

Figure 1: Circuits created using DigSim

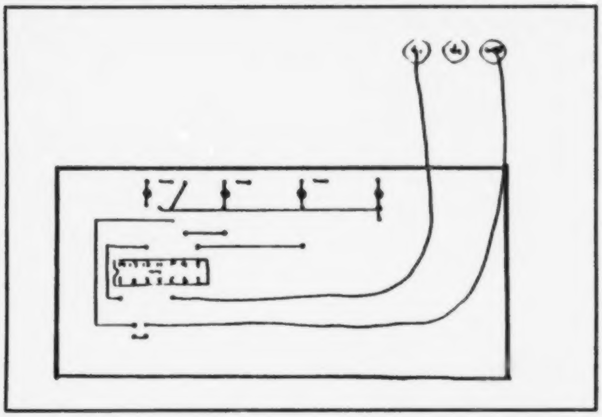


After building the circuits on the simulator, the students had a better understanding of how the various types of gates worked. They were now ready to enter the lab, and actually build a circuit.

At the start of the first lab, the technician explained how the multimeter and power supply worked and how they would be connected to the students' circuits. He also briefly discussed safety, such as how to avoid damaging the chip due to static, how to correctly connect grounds and power terminals, and how to remove a chip from the breadboard without damaging the pins on the chip or stabbing your finger on the chip's pins.

The first hardware experiment used only one 14 pin chip (7493) that contained four internal flip–flops and used four indicator lights (LEDs) to demonstrate a binary counting sequence. The LEDs were connected to the chip's output pins sequence. The LEDs were connected to the chip's output pins (in proper sequence or they counted backward). A push button pulser was used to change the status of the flip–flops and cause the lights to increment by one. This lab served as an introduction to the breadboard, wiring, reading and applying pin–outs for computer chips. The chip (with pins numbered) and wires were drawn on graph paper representing the insertion points on the breadboard. The power and ground wires also were shown. All this was done in class before the first lab. The diagram that the students used to construct their first circuit is shown in Figure 2.

Figure 2: Breadboard Diagram for Circuit Construction

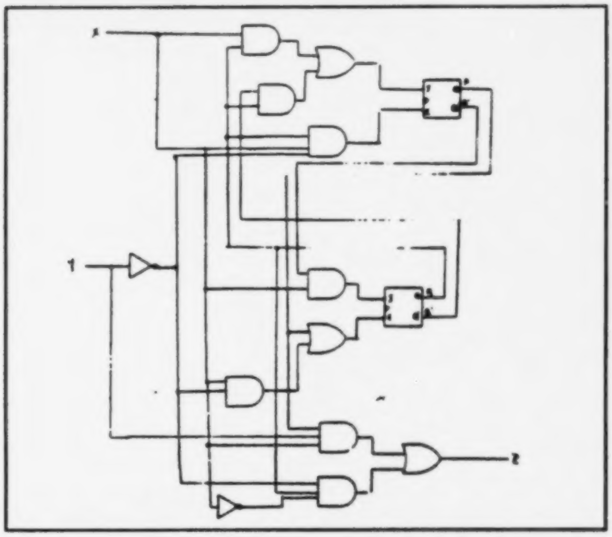


This lab was an excellent first experiment because the students had immediate feedback on whether the circuit worked or not (by the LEDs). If the circuit did not work, there was only one chip on which to verify the wiring, and there was not an abundance of wires to check. The simplicity of the lab also allowed the students to learn how to read the chip's pin–out and circuit diagrams. One problem encountered in this lab was the use of internal flip–flops, which the students had not yet studied.

The second experiment demonstrated the relationship between a Boolean function and the corresponding logic diagram. The Boolean functions were given as the sum of the minterms and were to be simplified using Karnaugh–maps. The students then constructed a logic diagram using NAND gates. Using a 7400 2–input NAND chip and a 7410 3–input NAND chip, they then built and tested the circuit using an LED for output. The groups of students were given class time to work together to design their circuit so that in the lab all they had to do was build the circuit.

The final lab was done the last week of school. This involved creating a sequential circuit that used two JK flip–flops, two inputs and one output. They were given simplified equations in terms of the flip–flop input functions and the circuit output function. Using these equations they were to draw the logic diagram of the circuit, tabulate the state table and derive the next–state equations. Using this information, they were to use a pin–out chart to determine the types of chips they would need, then finally construct and test their circuit. The problem required the following chips: 7476 – Dual JK M/S flip flop; 7408 – Quad 2–input AND gate; 7411 – Triple 3–input AND gate; 7404 – Hex inverter; 7432 – Quad 2–input OR gate. The logic diagram is shown in Figure 3.

Figure 3: Logic Diagram for Final Lab



This final lab applied the theoretical knowledge learned in the lectures, and culminated in the construction of a circuit that would test their conclusion (circuit). It served as an excellent conclusion to the course.

Course Evaluation

This course was one of the most challenging courses I have taught. The material was different from programming concept classes and, at times, was very mathematical. It was interesting to watch the students realize that this course presented a totally different sphere of computer science, one some of them really liked. In previous courses, they programmed incrementation or counting, but in the first lab, they actually built the hardware to count. The labs gave the students the chance to connect the theoretical aspects of software taught in the classroom with the hardware reality of the logical diagrams.

The book was excellent for a beginning Computer Architecture course. It contained many examples in basic electronics and logic gate implementation that were clearly explained, with references to previous material. The problems after the chapter reinforced the material with most of the problem's answers in the Appendix.

In the student's evaluation of the course, they focused primarily on the labs, stating the labs made the class more educational, interesting and enjoyable. The students felt at times they learned more doing the lab work then they did in the lectures and homework. They enjoyed constructing the circuits, trying to figure out how to connect the chip's pins and

LEDs to achieve their objective. Some students were amazed at the many different kinds of chips needed to accomplish a simple function. In the last lab, the students expressed concern that the breadboard was too small for the number of chips used, making it difficult to arrange the chips and wires in a way they could trace the wires if necessary. All the students felt they benefitted from working in a group, but would have preferred a group size of two students rather than three.

Conclusion

A course in Computer Architecture should be required for all students majoring in Computer Science. The material presented is a unique discipline of Computer Science, one that the students may never see elsewhere. One full semester allows enough time to cover the material but lab time must be built into the course. Due to the inherent dangers of working with electricity, and the student's unfamiliarity with computer components and test equipment, a lab technician is extremely useful.

The labs should be two hours long but not necessarily every week. The labs are best done in groups of two, with the problem presented before the lab time. The ideal hardware for the labs is a computer workstation that includes a pulser and power supply. An alternative is medium size breadboards, purchasing the pulser and power supply separately and sharing them between two groups. The test equipment, i.e., multimeter, also could be shared.

Summarizing the material and cost of a computer architecture lab for each group of two students: Breadboard $10; Wire, chips, LEDs $20; power supply (for two groups) $50; Test equipment (for two groups) $30. This cost makes it feasible to institute a Computer Architecture in almost any curriculum.

References

Denning, Peter J., et al., *Report of the ACM Task Force on the Core of Computer Science*, Aug. 12, 1988.

Eerkes, Gary L., Profiling Computer Science Master's Programs," *Communications of the ACM*, January 1991, pp. 86–109. *Goucher College Academic Catalogue*, 1992–1993.

Jameco Electronic Components Computer Products, 1992 Annual Catalogue.

Mano, M. Morris, *Digital Design*, Prentice–Hall, Inc., 1991.

Tucker, Allen, B., et al., *Computing Curricula 1991*, Report of the ACM/IEEE–CS Joint Curriculum Task Force, Dec. 17, 1990.

Acknowledgement

I would like to thank Mitchell Pittinger for all of his help and technical support. Without the generous donation of his tools and his time, this course could never have succeeded.

Projects (T4.7)
Computer Science

Teaching Programming Logic Using Computer Controlled Robots

Bob Coil and Ed Harper
Cincinnati Technical College
Cincinnati, OH

Abstract

We have been teaching a Programming Logic class separate from the programming language courses. The students use flowcharting, pseudocode, and other techniques to develop the computer logic needed to solve common business programming problems. The drawback to a separate course is the lack of feedback during the problem solving process. The instructor must also read every line of code and try to figure out the student's logic and discover where help is needed. We plan to experiment with a Fishertechnik computer controlled model kit and the process control software "Lucky Logic" as a means of adding feedback to the process. Since many students learn better when they manipulate something during the learning process, we also hope to see an improvement in student achievement. Our proposal is to report on this experiment.

While we will be using commercial products, our emphasis is on the learning process and the results, not on the promotion of specific products.

This abstract was taken from the author's originally submitted proposal

QBasic Programming—Creative, Challenging, Cheap

Theresa Cuprak and Jill Jones
Carl Hayden High School Center for Computer Studies
Phoenix, AZ

Abstract

Logo? Pascal? Scheme? Basic? Which language is the best for teaching programming and problem solving skills on the computer? Educators will never agree on this one, but we would like to share why QBasic is the starting point in the Computer Science curriculum at Carl Hayden High School. The ideas and projects presented will be appropriate for Jr. High as well as High School computer classes. We designed the introductory programming curriculum with the following philosophy:

—The projects should be enjoyable
—The projects should be understandable and doable for every student
—The projects should encourage the growth of problem solving skills
—The projects should teach structured, top-down design

QBasic has many advantages as a language. It is an easy language to learn and use. It is structured and makes using procedures and passing parameters easy for beginning students. It is widely available and inexpensive, as it comes with all new versions of DOS. The best part of our curriculum from the students' standpoint is the emphasis on graphics projects. They enjoy creating pictures and stories and are more likely to be successful programmers at this level. Using QBasic instead of Pascal in our first class has resulted in improved achievement in all of our advanced programming classes.

E.S.C.A.P.E.—Expert System Computer Aided Programming Educator

Joyce Morrison and W. Eugene Simmons
University of Southern Mississippi
Long Beach, MS

Abstract

A Knowledge-Based Expert System (KBES) is being developed as an instructional method for both teachers and students who are at varying levels of ability and experience. Written in OPS83 and Turbo C, this model is intended to be used as a step-by-step walk through of computer skills and the Pascal language. Its distinguishing characteristic is that the student may begin the walk at any level of expertise he chooses, thus avoiding meaningless repetition. The combination of screen graphics and the expert system enables this software to mimic a human professor through presentation, interaction, illustration, and testing. This tutorial will provide the means for a student to obtain programming experience with a patient teacher looking over his shoulder. The expert system controls the student's progress based on the student's test scores. This system may eventually be used to teach almost any subject by merely changing the database. It can serve as a supplemental tutor to both the classroom and the text.

Projects (T4.8)
Hypermedia

Interpretations of Whole Number Operations: Multimedia in K-4 Mathematics

Mary Jane Ford, Anne Fontaine, and Carol Scott Whelan
University of Southwestern Louisiana
Lafayette, LA

Abstract

Children who are learning the whole number operations in the elementary grades view the various situations (or interpretations) in each whole number operation as different types of problems. Therefore, teachers should provide experiences with all the interpretations for each operation at the appropriate level. To do this, teachers must be able to recognize these various interpretation and design experiences for each situation.

An approach for using interactive media to provide experiences with each interpretation was devised. A HyperCard stack was designed to present all four whole number operations with their various interpretations. Since some interpretations have multiple types, experiences with all types were also included. The HyperCard stack includes the use of laser disc graphics and animated graphics as representations of the interpretations. The stack can be used by the teacher as a demonstration resource or by the students as an instructional tool. The stack provides a demonstration of each interpretation, instructs students using a story problem for each interpretation, and allows the student to practice solving problems using various interpretations.

Molecules, Mammals, Learning Styles—Creative Use of Computers through HyperCard

Kathleen Haviland and Edward Sweetman
Emma Willard School
Troy, NY

Abstract

Introducing computing to young high school women enables them to view the computer as a normal extension of the tools available to them regardless of the discipline they wish to pursue.

For the past three years, several teachers at Emma Willard School have been developing, and in some instances asking students to develop, HyperCard stacks both individually and collaboratively for use in disciplines as diverse as humanities, foreign language, health and English.

The computer science department supports both faculty and curriculum by requiring in the mandated computer science course that each girl develop a generic HyperCard stack. HyperCard techniques can then be translated easily into projects for science, language, history, art, music, and mathematics. As a result, the Emma Willard student encounters computing in a natural way, in multiple subjects, and consequently, is not only the recipient but the creator of computer-generated programs.

The first part of the presentation will include a teacher-created, student-enhanced HyperCard stack demonstrating the use of HyperCard as a tool to integrate computers across the curriculum.

A discussion of what we do and how we do it will be the focus of the second part of the presentation. The specific project assigned to students encourages the use of the scanner, laser disks, sound, and graphics to augment their work.

Handouts available to members of the audience will include:

- copies of the four-week schedule for this lesson plan;
- sample text created on a word processor;
- sample thumbnail sketch each student makes for planning purposes;
- copies of a student created HyperCard stack.

Whole Language + Technology = Magic

Patricia S. Horn
Webster Elementary School
St. Augustine, FL

Abstract

You can turn kids on to learning by using technology to help you teach. The results are increased motivation plus a whole lot more. The presenter will share a whole language theme, Marine Science, that has been integrated with technology in the primary grades. Included in the support materials are teacher-made examples of interactive HyperCard stacks, computer-generated big and little books, puzzles, learning center activities, games, software, and samples of how to use laser discs with children's activities for these discs. Also samples of children's thematic work in word processing, spreadsheets, databases, and drawing programs will be shared. The presenter will give tips on integrating technology across the curriculum and will discuss management, evaluation, and parent communication techniques. Handouts on methods, materials, and resources will be provided.

All graphics and materials were drawn by me and scanned into the computer using an Apple flatbed scanner.

Collaborative Learning with Hypermedia-Based Instruction

Judi Repman, Herman Weller, and William Lan
Texas Tech University
Lubbock, TX

Abstract

The popularity of HBI in schools appears to be increasing rapidly. To date, attention has been focused on the effectiveness of HBI with individual students. Yet in many schools the hardware and software necessary to support large numbers of individual students utilizing HBI remains unavailable. This project was designed to investigate practical aspects of students engaged in collaborative learning via HBI.

Using *The Computer Ethics Stack*, the project investigated the impact of variations in social context on student achievement. Ninety-eight eighth-grade computer literacy students were randomly assigned to complete an HBI unit on computer ethics as individuals (magnet or non-magnet) or pairs (homogeneous magnet pairs, homogeneous non-magnet pairs, or heterogeneous magnet pairs). Magnet students outscored all other students. Non-magnet students working in homogeneous or heterogeneous pairs outscored non-magnet individuals. Differences in student approaches to the HBI were measured by comparison of the number of times students entered answers and accessed concepts. Articulation of concepts was measured by counting the number of thought units entered via the notepad. There was extreme variability in both approaches to the HBI unit and articulation of ideas during HBI between and within all social contexts.

Projects (T4.9)
Practical Issues

Faculty Computer Use in a College of Education and Allied Professions

Gregg Brownell, Ron Russell, and Nancy Brownell
Bowling Green State University
Bowling Green, OH

Dieter Zirkler
Mead Data Central
Dayton, OH

Abstract

This study tracks the computer use of faculty in a College of Education and Allied Professions in a large mid-western university during the first year of the implementation of a college-wide computing plan. Data was gathered as the plan was initially implemented at the beginning of the fall semester, and again at the close of the spring semester. Background data on faculty was gathered plus data on faculty use of computers for teaching, and for the research, publishing, service and professional presentation aspects of faculty activities. Data was also gathered on faculty use of computers in collaborative endeavors. Data will be presented and discussed to both describe faculty use of computers in the cited areas and to investigate any change in faculty activities during the first year of the plan. Implications for future activities will be discussed including the continuing development of the computer plan and the continuation of this study as a multiple year project.

Geographical Information Systems for School Administrators

Paul Cote and Kenneth Temkin
Newton Public Schools
Newtonville, MA

Abstract

Newton Public Schools has teamed up with the Massachusetts Institute of Technology's Department of Urban Studies and Planning to investigate educational applications of **Geographic Information Systems** technology. The Newton/MIT initiative represents a pioneering effort to enhance school administration services and reduce costs.

Geographic Information Systems, referred to as GIS, desktop mapping or data visualization, are computer software programs that tie maps to databases. In the words of one expert, "Using maps and your data together is a powerful way of understanding and communicating your message. Desktop mapping enables you to graphically manage, analyze, and present your data, and view the geographic results of your analysis." In the end, this new technology helps users and administrators make more efficient and effective decisions.

The city of Newton is a suburb of Boston consisting of 19 schools and 9,500 students. Newton Public Schools has taken a first step toward using GIS systems by 1) exploring possible applications of GIS for school administration, 2) evaluating various GIS software programs, 3) developing several prototype applications, and 4) preparing a GIS implementation strategy for school administrators.

In preparing a proposal and plan for implementing these tools at Newton's school headquarters, we have documented many of the critical issues involved in adopting this technology: 1) the existing policies and procedures involving spatial information; 2) the condition of useful databases; 3) staff skill development.

Our workshop will begin with an introduction into Geographical Information Systems. We will demonstrate the functions of GIS and various school administration applications including redistricting, program sitings, and transportation services. The second half of the workshop will be spent discussing the practical concerns of implementing GIS technology in different school administration settings. The experience will provide participants with a familiarity with Geographical Information Systems.

This abstract was taken from the author's originally submitted proposal

Computerized Adaptive Testing: Realizing New Relationships with Assessment

Arthur Doyle
College Level and State Services
New York, NY

Abstract

Computerized adaptive testing is a new alternate model of assessment providing needed benefits to students and faculty, including more accurate course placement and a much more personalized or tailored congruence with instruction. This new model of assessment removes the constraints imposed upon testing by the paper and pencil medium, unleashing creativity through more efficient and effective ways of determining what students know and can do. It is supported by a growing research base and a dramatically expanding user base of diverse colleges and universities throughout the United States and Canada. Among the creative uses being applied are the advanced identification and development of marginally remedial students, the use of computer delivered testing for academic in-course progress monitoring, the evaluation of the effectiveness of developmental education interventions, improved resource allocation, and on-site collaboratives with business and industry or feeder high schools. This session will focus on an understanding of and on the application of this capacity.

Use of a supporting management software system allows for greater institutional utilization of technical resources and a more flexible alignment of human resources. Attributes such as Seamless Serial Testing provide economic and time-saving features that allow "more to be done with less." New developments now underway will respond to expressed institutional needs such as improved assessment for ESL populations, diagnostic and prognostic assessments, and the use of constructed response item formats.

This presentation and discussion will focus on how branching leads to more accurate course placement, the impact of computer-delivered testing in the student support process, the use of results in instruction and retention, the one-stop assessment center with on-site academic advising, additional supporting services such as seamless serial testing and computerized placement advising.

This abstract was taken from the author's originally submitted proposal

A Boys Network: Melton Fellows Global Network

Mei-Yau Shih
LeMars, IA

Abstract

This presentation was a summary of a comprehensive evaluation of the Melton Fellows Program at Teikyo Westmar University in LeMars, Iowa. The evaluation was an attempt to investigate the Melton Fellows Program's effectiveness on provision of cross-cultural communications and the applications of computer technology in establishing a global educational network. Throughout this thorough evaluation, overall weaknesses and strengths of program were stated, and future directions of the program were suggested.

The application of computer technology in the Melton Fellows Program has brought with it the new horizon of use of telecommunications at an U.S. midwest small town. The adoption of new technology as well as the effects of the program on cross-cultural communications were examined through this evaluation within the framework of social context, organizational structure and program transformation over time. In addition, this study was an effort to inquire into the issues surrounding the implications of educational technology in a given environment, and the exertion of human adjustment to the technology within that very situation.

Projects (T4.10)
Multimedia

The CAISYS Project: An Interactive Videodisc Solution for Information Dissemination

Randall Coorough, Randall Stovall, and Edmund Gross
Valencia Community College
Orlando, FL

Abstract

This presentation will describe and demonstrate an innovative interactive videodisc program called the College Academic Information System (CAISYS). CAISYS is designed to provide academic information to current and prospective students, as well as visitors of Valencia Community College and the University of Central Florida. The CAISYS program utilizes state-of-the art interactive videodisc technology to orient people to the academic programs, academic support services, financial aid, admissions, articulation, student activities, and campus resources and facilities at these two fast growing institutions.

CAISYS will provide a flexible and convenient system for recruiting, promotion, and information delivery at on-campus and off-campus locations while requiring minimal commitment of human resources. The kiosk-based system's user-friendly touchscreen, captivating computer graphics, audio, and video make CAISYS an effective medium for providing educational information.

In addition to the wealth of academic information that CAISYS provides, the program also serves as a system to solicit user feedback and survey data, which will provide valuable statistics for refining information delivery, content, and system tracking. To keep pace with the dynamic nature of these two fast growing institutions, CAISYS is designed as an open ended system where future expansion is unlimited.

The CAISYS project is a non-commercial product/venture.

This abstract was taken from the author's originally submitted proposal

Food for Speech: "Can We Eat Now?"

Debra Freedman
New York City Board of Education
Brooklyn, NY

Abstract

Food is an important part of a teenager's life. So why not combine food, speech, computers, video and the VCR and prepare lunch for our classmates. This sounded like a great idea to the students at MS (Middle School) 88 in Park Slope, Brooklyn, New York.

The students involved are students mandated for Speech and Language Therapy; included are mentally retarded, neurologically impaired, physically handicapped, and learning disabled. They are learning speech through "eating". We achieve this goal by using the "whole language" approach together with collaborative learning and peer tutoring in a multimedia environment. This approach helps the students use natural language necessary for survival. The students learn to plan, organize, and prepare a luncheon for their peers. Pragmatic skills in both language and everyday situations are being developed.

The object of the project is to facilitate the communication process improving sequencing skills, self expression, and self esteem. We use the computer, video recorder and VCR to develop the above skills. The students use word processing for planning and preparing the menu and invitations; video for self and peer evaluation of the communication process. Watching the specific task of preparing a luncheon of pizza and dessert is a learning experience. The excitement of the students shows that the Magic of Technology does help in the developing of communication skills.

Instruction With Digitized Video: Putting the Focus on Instruction

Michael Land and Phyllis Hotchkiss
Midwestern State University
Wichita Falls, TX

Abstract

We in computer/technology education have become enamored with the technology and for all practical purposes have ignored the implications for the preservice and inservice teacher. Too many of us know something or perhaps a great deal about computers, but very little about the instructional process; others of us know a great deal about instruction, but almost nothing about the use of technology. The purpose of this session is to share examples of instructional techniques and lessons in which digitized video enhances the lesson rather than being the focus of the lesson. One of the presenters is a specialist in instruction and computer education; the other presenter is a specialist in instruction who has integrated the use of technology into her teaching.

Building Interactive Language Simulations: Crossing the Border Without Leaving Home

Marianne Phinney, April Koch, and Jaime Nuñez-Cruz
University of Texas at El Paso
El Paso, TX

Abstract

This project will demonstrate programs developed for Macintosh and Amiga computers for interactive multimedia language instruction. The programs include real-time simulations of everyday activities, listening comprehension, and speech production. Video sequences shot on both sides of the Mexico-U.S. border involve unscripted interactions, such as bargaining in the market, having dinner in a private home, making travel reservations, and going to the doctor. These have been restructured and edited for the interactive lessons to accompany basic language classes or for self-study. The programs also include instructor utilities that will allow teachers to develop additional lessons.

The project developed lessons in Spanish and English as a Second Language (ESOL), both of which are in great demand at UTEP. The lessons allow students to receive more language input and to practice interactions before trying them in the "real world." Students can insert themselves into the scenario by using digitized speech to incorporate their responses.

On the Macintosh, the programs are developed in HyperCard using QuickTime extensions for digitized video clips. On the Amiga, the programs are developed in CanDo and AmigaVision Professional using digitized video and Amiga standard ANIM files.

Projects (T4.11)
Multimedia

Multimedia Portfolios: Stories and Presentations

Sandra Becker and Leroy Tuscher
Lehigh University
Bethlehem, PA

Abstract

This outcome-based education affords students the opportunity to assume ownership of projects and to express themselves creatively using Digitized Video Interactive (DVI), audio, text, graphics, and hyperlinks. The program is highly interactive and allows the student or groups of students to craft libraries of information and to create new data.

Today the designers will share two examples of student work. The Research and Development team have been working with middle school youngsters and their teachers to develop activities that use higher order thinking skills. The students complete games, stories, and hands-on projects. They enter the results into the computer and use tools that were developed by the Educational Technology Center. The assessment collection and evaluation procedure will be outlined briefly.

This abstract was taken from the author's originally submitted proposal

Research and Writing in High School: The Electronic Alternative

Ann Bleakley
Plainfield High School
Plainfield, IN

Abstract

To prepare literate participants for post-secondary education, for the work force, and for a myriad of other responsibilities in adult society is an indisputable goal of the secondary school. With the vast amount of information available today, an effective secondary English program must include training in the selection of appropriate information sources, valid manipulation of data, and meaningful communication of results.

With this perspective the media specialist and English teachers at Plainfield (IN) High School embarked on a collaborative venture to empower our students to become more precise researchers and writers as they used word processing, electronic databases, multimedia, and telecommunications in an atmosphere of cooperative learning. Our efforts have culminated in a program that covers four years of English classes and reaches all students, regardless of ability level.

This overview includes the introduction all ninth- and tenth-grade students receive to word processing and electronic resources as well as selected assignments for other students. Handouts for learning activities are provided.

Project Einstein: Integrating Multimedia Into The Curriculum

Nancy Elnor
Longfellow Intermediate School
San Francisco, CA

David Hehman
Creative Programming Creations
Berkeley, CA

Abstract

In a 10 week pilot multimedia project, sixth grade students researched video, computer-based, laserdisc, and print resources to present multimedia shows on ancient civilizations. Students worked cooperatively in mixed-ability groups.

The study of ancient civilizations in the sixth grade is part of an articulated curriculum laid out in the California Framework for history-social studies. As stressed in the Framework, students learn in preparing their multimedia presentations to both obtain information and judge its value, reaching reasoned conclusions based on evidence and developing sound judgment. Students also learn to discuss, to debate, and thus, to create a well-reasoned and well-organized presentation. Throughout their work in cooperative groups, they learn group interaction skills, critical thinking skills (including defining and clarifying problems), and how to draw conclusions.

This mode of presentation provided an excellent opportunity to integrate the curriculum as students learned the traditional literacies of reading, writing. listening, speaking, visual and media literacy, as well as math, science, and the arts of the ancients. Also, students' past successes with performing before audiences resulted in increased learning and improved self-esteem. Additionally, students are eager to work with computers. The choice of multimedia was also influenced by the California (State) Technology Project and District leadership, which are encouraging adoption of multimedia.

Longfellow School reflects the social and racial diversity typical of many inner-city schools. Fifty-five percent of the students are African-American, 20% Caucasian, and 25% Hispanic, Asian, or other minorities. Students come from a wide range of socio-economic backgrounds, and many come from backgrounds with numerous image debilitating factors or suffer from the breakdown of traditional family support systems. Forty percent are Chapter 1. Atypically, 20% of the students are GATE.

Project Einstein is based on collaboration among teachers, industry partner staff from Creative programming Creations (a Berkeley-based multimedia software developer), parents, and tutors from the University of California and is supported by product donations from Microsoft Corp., Autodesk Education Foundation, MacroMind, Authorware, and Media Vision. The unique aspect of Project Einstein is the on-site support by and presence of industry.

Interactive Laserdisc Anesthesia Simulation for Veterinary Technology Students

Guy Hancock
St. Petersburg Community College
St. Petersburg, FL

Abstract

More Anesthesia, Please! is a simulation of canine anesthesia created to assist students practicing anesthetic technique. The benefits of using interactive technology are that students can:

- repeat the lesson as often as desired
- proceed at their own pace
- emphasize particular areas of interest or weakness
- learn from mistakes in a safe, non-threatening, and private environment
- achieve greater anesthesia skills
- reduce the use of live animals

The presenter will demonstrate the project and discuss various aspects of the software, lesson design, authoring process, and experiences using SuperCard.

Projects (T4.12)
Telecommunication

Telecommunications and "Society's Problems: Links Between Prisons and Classrooms"

Bill Burrall
Moundsville Junior High School
Moundsville, WV

Jay Vickers
West Virginia Office of Institutional Education Services
Moundsville, WV

Abstract

Telecommunications can offer students a means of discussing society's problems while developing an understanding of the complex social forces at work that result in immoral and criminal behavior.

Prisons are populated with individuals who are so-called social misfits who have violated our laws. But many prisoners become so as a direct result of society's problems themselves. Many prisoners share a common background of child abuse and neglect, poverty, family problems and violence which are just a few of the causes leading to their separation from society. Sometimes, this isolation from society serves only to isolate thoughts and does little to prevent the same mistakes from being repeated by others.

Students from Moundsville Jr. High School in West Virginia served as the link between eleven inmates from the state's maximum security prison, and classrooms from Alaska, Belgium, Hawaii, California, Louisiana, Missouri, England, Canada, Ohio, and Bermuda. Students involved were able to, via e-mail, establish a dialogue with the inmates and discuss causes and effects of society's problems. Communications took place through AT&T's Learning Network and the state prison's electronic bulletin board. Each participating school was assigned an inmate with whom to communicate over a twelve week period. Students developed questions to send via e-mail to the West Virginia school, which in turn relayed them to the prison inmates via local BBS. Inmate responses were then relayed back to the distant learners via the global network.

Copies of the group publication, including dialog between the schools and inmates will be available at the presentation.

The Middle-Level Student Becomes A Global Scientist

Scott Dixon
Boulder Valley Public Schools
Boulder, CO

Abstract

Kids as Global Scientists is a NSF funded project which begins to demonstrate what students can do when they have access to both human and electronic resources on the world-wide Internet network.

During this month-long curriculum project, students become the creators and distributors of authentic information. Students in six classrooms around the U.S. and in Australia split up into small working groups with at least one group at each site studying specific local weather phenomena (wind, precipitation, clouds and humidity, severe weather, and environmental issues). Each group used local resources as well as Internet resources (atmospheric scientists, graduate students, real-time data and satellite imagery) to research their chosen topic. As each group developed expertise, they shared their acquired knowledge via electronic mail. The culmination of this collaborative project was a book produced by each group.

To facilitate the use of the network, a HyperCard front-end has been developed. This interface allows students to bypass technical hurdles normally involved in downloading satellite maps, facilitates e-mail, and keeps track of information, including the global partners.

Access to real-time data and on-line experts provided these students with a valuable educational experience that could not be replicated within the confines of the traditional school curricula.

The Integration of Telecommunications Into Special Education Student Teaching

Wenfan Yan, Julie A. Poage, and Dorie Munson
Gonzaga University
Spokane, WA

Abstract

Technology has become an integral part of most teacher education programs. Yet the student teaching experience provides a unique challenge in the area of technology integration. Many student teachers experience a sense of isolation as they leave the university environment and begin their field experience. Not only do students leave the familiar surroundings of the university campus, but they are no longer in direct contact with peers or faculty that might serve as a resource during their student teaching experience.

At Gonzaga University, a pilot project is underway that will utilize electronic mail as a conduit for communications among and between student teachers, university supervisors, teacher education faculty, and participating classroom teachers. Data will be gathered indicating reflective thinking about student teaching, effective indicators about student teaching, and effective indicators about the use of technology. By using electronic mail, we imagine that student teachers will be more willing to ask how they might do things differently and consider alternative approaches to the handling of challenging situations. They will also be more likely to share their experiences with others and to benefit from being not only the giver, but also the receiver of information.

Posters (T4.13)
Technology in the Curriculum

Telecommunications and Social Studies: Two Successful Projects
Gerald Crisci
Scarsdale Public Schools
Scarsdale, NY

Algebra Motivation by Computer Assisted Instruction
Cheryl Feser and Alex Reyes
Carl Hayden High School
Phoenix, AZ

"Set on Freedom:" History, Hypermedia and Criss-Crossed Conceptual Domains
Karen Swan and Marco Mitrani
State University of New York at Albany
Albany, NY

Using Spread Sheets/Graphing To Teach a Variety of Science Lessons
William Sumrall
McNeese State University
Lake Charles, LA

Gene Aronin
Northeastern Illinois University

Wednesday

Spotlight Sessions (W1.1)

NSF Funding Opportunities for Undergraduate Computer Science

Doris Lidtke
National Science Foundation
Silver Spring, MD

Abstract

This session will discuss those programs at NSF which are currently accepting proposals deemed to be of interest to the conference attendees. These will cover the subject areas of computer science, information science, and engineering and will include those programs which support the educational infrastructure, research instrumentation, curriculum development, faculty development, and laboratory instrumentation. Audience questions will be welcomed.

Society Sessions (W1.2)

Ethics Curricula—Issues and Suggestions: A Panel Discussion
Consortium for Computing in Small Colleges (CCSC)
Barbara Boucher-Owens
St. Edward's University
Austin, TX

Abstract

The panel will discuss the inclusion of ethics as a topic for study by students in computing. Gail Miles will cover practical suggestions about where in the curriculum such issues can be introduced and will present a sample syllabus. Wally Roth will address how his institution includes ethical components in all dealings with students, and concentrates on their ethical growth. He will also discuss materials that he uses in this process. Don Gotterbarn will offer alternative curricular suggestions which integrate ethical considerations in particular problem sets presented to computer science students. Frank Connolly will engage the panel and the audience in some particularly intriguing case studies. He will also outline the status of EDUCOM's ethics project.

Panelists:

Gail Miles
Lenoir-Rhyne College
Hickory, NC

R. Waldo Roth,
Taylor University
Upland, IN

Don Gotterbarn
East Tennessee State University
Johnson City, TN

Frank Connolly
American University & EDUCOM
Washington, DC

Society Sessions (W1.3)

New Knowledge Networking Contest
International Society for Technology in Education (ISTE)
Anita Best, Panel Chair
International Society for Technology in Education
Eugene, OR

Abstract

The International Society for Technology in Education (ISTE), Novell, and other hardware and software companies sponsored a contest to encourage districts/schools to identify and plan networking as a cost effective way to access/share information resources and expand student learning experiences. The judges and winner will discuss the winning solutions and give state-of-the-art network design ideas for schools and districts.

There were three prize categories—one for integrated administrative and instructional uses, one for administrative uses, and one for instructional uses.

The winner of the grand prize for administrative and instructional uses was Greensburg Salem School District in Greensburg, Pennsylvania. This district has made impressive efforts toward restructuring their high school and middle school, including a project where high school students use notebook computers to go out into the community and educate interested residents about computer skills . They will use the grand prize hardware and software to incorporate their three elementary schools into the network of technology at the high school, middle school, and district office. The elementary networks will be used for administrative and curricular purposes. Having connecting computers across all the grades will enable teachers to develop curriculum for multi-age groupings as well as continue with the on-line researching and telecommunications activities that are already going on.

The winner of the education prize was Fairport Central School District in Fairport, New York. Their proposal will create an interdisciplinary learning environment by linking Social Studies and English classrooms. They will expand their present local area network into a wide area network to provide students with opportunities to develop higher level researching techniques, promote cooperative learning, create electronic portfolios, generate authentic assessment tools, increase teacher communication skills, and open doors to local universities and national information centers.

The winner of the administrative prize was Santa Maria-Bonita School District in Santa Maria, California. Faced with a highly mobile population, the Santa Maria-Bonita School District plans to use its new hardware and software to establish a wide area network (WAN) to enable all schools to have access to the information that is collected at each school site and other district sites. The WAN will enable schools to obtain student information immediately when a student registers for school, and then using this information, provide the best instructional program and materials to meet the student's needs.

Panelists:

David Cullen
Greensburg Salem School District
Greensburg, PA

Robert J. Iannuzzi
Fairport Central School District
Fairport, NY

Michael R. Anderson
Santa Maria-Bonita School District
Santa Maria, CA

Pat Leonard
Jefferson County Public Schools
Colorado

Dave Brittain
Florida Department of Education
Tallahassee, FL

Ron Dries
Jefferson County Public Schools
Colorado

Bruce Nelson
Novell
Provo, UT

Lary Smith
Wayne County Regional Educational Service Agency
Wayne, MI

Paper (W1.4a)

Preparing the Next Millennium's Leaders: Advocating Technologically Competent Elementary Principals

John F. Beaver
SUNY College at Buffalo, New York

Abstract

The past decade witnessed the rise of many crucial social issues that captured the national spotlight and called for immediate solutions. During these same years, many schools had fewer resources available to them. This combination of increased demands and dwindling resources promises programmatic chaos unless educational leaders with clear understanding of their instructional technology program needs develop long-range plans to insure these needs are met. Unfortunately, few such leaders exist.

Developing consistent, comprehensive long-range plans to nurture educational technology programs requires leaders with a deep understanding of both the problems and promises of educational technology. A recent study conducted with 107 elementary school principals in Western New York indicates that our educational leaders lack the technology competence they will need to guide their schools with wisdom into the next millennium. This paper will discuss the results from the study, and the entire survey instrument and findings are included at the end of the paper.

This study suggests that many elementary school principals currently lack the technology competence needed to guide and nurture their instructional programs' development. To improve this deficiency, these educational leaders must be provided with training programs to help them develop sufficient understanding to guide their instructional technology programs. Some essential elements of educational leadership technology training programs are presented and discussed, followed by an argument for requiring similar training elements in all state administrative certification programs.

Introduction

The late 1980s witnessed the rise of many crucial social issues that captured the national spotlight with a need for immediate solutions. An increased emphasis on drug education, prevention of teen pregnancy, AIDS awareness, and other current concerns have caused school administrators to shift their attention, and their funds, from instructional computing to other programs. As Mary Jo Langhorne, et al, suggest: "The use of computers in education is not the compelling issue it was five—or even two—years ago. New bandwagons have presented themselves: Higher order thinking skills, merit pay plans, and objective-based education now compete for the attention and funding computers received but a short time ago." Although educational computing received strong public support in the early and middle 1980s, many new issues currently monopolize American educational and social concerns.

During the past half-decade, most schools have had fewer resources available to them. When "belt tightening" takes place, some programs—perceived as luxuries—receive insufficient support. How have instructional computing programs fared in this environment of financial instability and diminished support for educational endeavors? In 1987, I conducted a national study of outstanding elementary school instructional computing programs. One disturbing finding was that the schools' computer budgets were, even then, very volatile, with few schools having established computer expenses as permanent line items in their school budgets. As Kathleen Fulton reports, the Office of Technical Assistance found similar tendencies: state-level profiles indicate that state support for technology in education is subject to volatile economic conditions as well as political and educational priorities in the individual states.

Another pattern to emerge from the Beaver 1987 study was that funding levels for instructional computing programs declined dramatically during the late 1980s. The findings indicate that many administrators felt they had already paid their dues by purchasing some necessary hardware. They were then prepared to allow other important educational issues to take financial precedence. For the most part, they lacked long-range plans to guide the steady development of their programs.

In addition to the fiscal instabilities, some sources continue to challenge the importance of using computers educationally. A recent *New York Times* headline states: "Computers are in the classroom, but no one is paying much attention to them." A headline in the *Wall Street Journal* reads: "Computers Failing as Teaching Aids." Even the media suggest a reduction of interest in educational computing at a time when more support is needed to ensure maintenance of programs. As Langhorne, et al, point out: "...there are those who are already concerned about the waning interest in instructional computing and the decline in financial support for microcomputers." This conflict augers programmatic chaos unless school leaders provide guidance and support. Leaders must develop clear understanding of instructional computing program needs to enable them to develop long-range plans to insure continued growth—or even continuation—of the programs. Unfortunately, too few school leaders have the necessary computer competence, and consequently, far too few comprehensive plans exist.

The Problem

A recent National School Board Association survey of American school districts concluded that there is little evidence of comprehensive planning for educational computing programs. The survey findings conclude that most district plans "did not have a comprehensive flavor." Why is this? Developing a comprehensive, long-range plan to support an educational computing program requires a leader with a deep understanding of the problems and potential of instructional computing. Many of our administrators simply have not reached this understanding. As Greg Kearsley contends: "administrators often lack any suitable preparation to effectively manage the computing activities in their schools." I agree: our administrators are being asked to make decisions on a topic for which they are not prepared.

If we expect educational administrators to provide the vision and understanding needed to guide the development of instructional computing programs, we must encourage them to increase their computer competence. As Sylvia Charp argues: "It is generally agreed that more still needs to be done in faculty development if we expect truly broad use of technology in teaching and learning to occur. This should include programs designed for administrators of all levels, to enhance their awareness of technological literacy and their competence in planning for technology utilization." The administrative programs Charp references should not be limited to inservice experiences, but should include college level instruction that constitutes a portion of the required program for state administrative certification.

According to Kathleen Fulton only "...18 states require...that all students in their teaching degree programs or those seeking certification take a course on [educational] computer topics." Nearly one-third of our states value educational computing enough to mandate it in their teacher education programs. Still, if less than one-third of the states require computer education for teacher certification, far fewer require a similar course designed for administrators. Without such experience to help administrators develop the computer competencies they need, no clear vision will guide instructional computing programs.

Many educational leaders have called for greatly increased computer training for our teachers. According to Tom Snyder, "We all made a serious mistake in giving the computers to the kids first. We ignored the teachers, cut them out of the loop, and that's precisely the way to kill a promising educational technology." Although Len Scrogan includes other limiting factors, he agrees with Snyder's main point: "Why isn't technology having a greater impact? Many factors are to blame: insufficient access to computers, inadequate supplies of quality software, and pauper technology budgets all contribute....[but] the most significant factor lies in the fact that the vast majority of teachers today have little or no training in the use of the new technologies."

Granted, teachers *do* need assistance with using technology instructionally. Certainly, empowering our teachers by raising their level of technological competence is very important. I endorse greatly increased staff development efforts to raise teachers' technological understanding, familiarity, and facility. But who is in the best position to insure the necessary provision of logistical, financial, and psychological support for teachers? Local administrators, of course—*if* the administrators understand the unique need for support that instructional computing adoption requires. If the promises of educational technology are to be kept, the education of our administrators is equally, perhaps more, important. When the computer revolution was started, somehow we forgot to invite the educational administrators.

This survey suggests that many administrators have limited hands-on experience with microcomputers. Without personal experience, they cannot genuinely understand the need for continuing support that instructional computing demands. Administrators have to develop an experiential base to guide their instructional computing programs. As computer educator David D. Thornburg argues, "Educational computing took its sabbatical last year, and now it's time to get to work, recharged and reinvigorated with energy and enthusiasm. Yes, additional hardware costs more money, but that's not the problem. The problem, as I see it, comes from a lack of vision." Although I agree with Thornburg, I suggest that the road to vision includes journeys through the "slough of frustration"—lost files, confusing screen displays, unclear support documentation, printer malfunctions, hardware and software incompatibilities, information overload—to the "highlands of empowerment"—polished document production, facile data manipulation, swift numerical analysis, powerful instructional delivery. If administrators have no personal experience with microcomputers, they cannot really understand the training and support that teachers need to help them master the machines and accompanying software. Without such understanding, developing a stable, far-reaching vision for educational technology is not likely.

The need for administrators experienced with educational technology was brought home sharply to me last year when I taught a course at SUNY College at Buffalo titled "Administrative Uses of Microcomputers.". The course is an elective in the educational administration certification program. Participants are aspiring administrators, individuals seeking administrative certification as a precursor to finding an administrative position. Nearly half of those enrolled had *no* previous computer experience—none! Some were not even familiar with a keyboard. Most of those without experience shared another characteristic: they were afraid of computers. That fear is a fear of the unknown. And that fear, as with all fears of the strange or unusual, dissipates with understanding and familiarity. But those qualities only come with actual computer experience.

The course proved rigorous for those starting from scratch, designed as it was to provide a broad range of technology experiences and insights to participants. However, after completing the course, the participant consensus was that the hands-on expectations provided a critical part of their learning experience. Their responses suggested that without the opportunity to master the technology for themselves, they would not have understood the powers and the problems of technology adoption. When they eventually receive administrative appointments, these leaders-of-the-future will not be guilty of "dumping" hardware on untrained teachers. Because of their hands-on triumphs and frustrations, they now understand the need for continued, substantial support—both financial and psychological.

The Study

The responses to the course argue strongly for the need to develop technologically competent educational leaders. From anecdotal data from my own classes and my periodic visits to schools, I was persuaded that many educational leaders currently lack technology competence. Nevertheless, I wanted to verify these informal perceptions by gathering tangible data from a larger sample of educational leaders.

In April, 1991, I was asked to survey a group of 75 administrators (with a 79% response rate) for the Leadership 2000 Program in South Central Florida to determine their technology competence. The Leadership 2000 Program was originally designed to prepare a selected group of individuals from varied administrative situations for the administrative opportunities of the next millennium. The survey findings from the 59 respondents revealed a significant lack of technology experience among the participants in the program, but the data were difficult to generalize because the study's population included representatives from academe and district offices to elementary, middle, and high school building level principals. The findings convinced me to replicate the study with a more homogeneous sample of leaders—elementary school building principals.

In May, 1992, I surveyed a group of 107 randomly selected elementary school building principals from Western New York to determine their technology competence. The data from the 61 respondents (a 57% response rate) were consistent with the findings from the earlier study. More important, these data provide a sample from which generalizable conclusions and recommendations are appropriate.

Findings

For a complete inspection of the data, the survey instrument, with the findings indicated, is attached to the end of this paper. However, some significant results are worth highlighting. Notably, from the first three survey questions, nearly half of the respondents (48%), do not have microcomputers in either their offices or homes. Not surprisingly, that same 48% report that they seldom use computers—in fact, less than an average of 1 hour per week. Naturally, individuals who spend little or no time using computer-related technologies on a regular basis are highly unlikely to understand the powers or the limitations of the technologies.

Since nearly half of the sample has such limited computer experience and hardware availability, it is not surprising that the principals report that they have received little formal technology training. Fully two-thirds (66%) indicated that they have never taken a course on the administrative applications of technology. In addition, an even greater number (68%) reported that they have received less than six hours of on-the-job training in the use of microcomputers. Unfortunately, even six hours is far too little to develop computer competence.

More encouraging is the finding that the principals recognize the need for additional training. In fact, 71% reported they would be willing to attend 12 or more hours of training sessions each year. Also encouraging is the result that nearly all of the respondents (94%) shared the opinion that, in their view, the appropriate use of educational technology is either "Very important" or "Of considerable importance" to their schools. However, despite their belief in the program's importance, 61% indicated that they are dissatisfied with their school's present educational technology program.

The principals want change, and they are the obvious individuals to guide the change process. Before the leaders can make informed decisions designed to nurture the growth of their schools educational technology programs, they will need to develop a far greater level of technology competence. This goal can only be achieved through an extensive program designed to develop our leaders' understanding of the powers and limitations of computer-related technologies.

Recommendations

To help our educational leaders develop the technology competence to wisely guide their programs into the next millennium, they must first participate in a program of education and training. This training must include practical applications, group discussions, preferably supplemented by individual and co-operative learning experiences, and opportunities to explore technology applications of educational significance. The practical applications should include the productivity enhancement standards: word processing, data base managing, print merging, spreadsheet developing, chart generating, and telecommunicating. While administrators master these tools, the focus should always be on demonstrating ways in which each application's powers enhance the role of an educational leader.

In addition to the practical applications, training participants should also engage in varied group discussions and problem solving experiences designed to offer leaders opportunities for applying their technology understanding. Important discussion topics include deciding on administrative computer uses, establishing optimal computer adoption approaches, creating stable computer budgets, determining computer placement, planning instructional computing programs, planning staff development of computer competencies, planning computer integration policies, and developing cost-effective policies for computer usage.

Beyond these individual and group discussion activities, participants should be asked to work in cooperative partnerships with job-similar administrators to reach a joint approach to mastering an emerging technology. After each team is familiar with its technology topic, the team should share the pertinent educational issues that the technology represents with the group-at-large. Potential topics include applications of telecommunications, advantages and disadvantages of integrated learning systems, uses of dedicated input devices (such as scanners and digitizers), advantages and disadvantages of local area networks, the costs and features provided by dedicated applications (like scheduling and attendance programs), the administrative implications of new technologies (including CD-ROM and interactive laser disks), and desktop publishing (and desktop presenting) applications.

The hands-on training, supplemented by the productivity applications, provides the leaders with new tools to enhance their effectiveness. The group discussions broaden and strengthen the principals' understanding of important educational technology issues. The partnership explorations of new technologies help administrators appreciate the time needed to master each new innovation. These combined experiences and understandings will prove useful to administrators when they plan and implement staff development projects designed to encourage the adoption of new technologies.

Conclusions

Each of the elements of the administrative computer competence training expectations is important. Without the hands-on experience, discussions become remote, theoretical experiences. Without the discussions, the hands-on experiences become simply software training workshops. Without the discussions and hands-on workshops, the technology presentations become "Show-And-Tell" sessions. However, the three components together provide a solid foundation for an administrative technology leadership capable of guiding schools steadily into the next decade. These training experiences will prepare leaders who can and will model appropriate technology uses in their own school classrooms and offices.

As Langhorne, et al, express the concern of many educational technology advocates: "Educators have an embarrassing history of adopting the latest fad, trying to make those fads meet all needs, becoming dissatisfied because the new idea did not bring success in every application, and so abandoning the innovation and moving on to the next." As advocates of educational technology, we do not want the computer to share the fate of instructional television and other educational innovations that are now passé. As Robert McCarthy suggests: "The computer is too powerful an educational tool to be cavalierly consigned to the educational broomcloset."

If we are to keep the computer out of McCarthy's broomcloset, we will need the vision and leadership of our school administrators. Our educational leaders must establish long range plans to guide their instructional computing programs. As the recommendations of the National Education Association's committee on educational technology suggest: "All schools should develop and implement a plan to install a computer with adequate software on the desk of each teacher by 1991. Resources for educational technology must be adequate to provide balanced support for staff development, software, hardware, and research into curriculum integration and development." To develop such plans, we must first develop informed, knowledgeable, and dedicated planners, planners who have learned the powers and pitfalls of educational technology adoption. The only way to avoid the computer broom closet is to require our leaders to raise their computer competence. That goal can best be accomplished with an instructional program dedicated to that purpose. To achieve full administrative awareness, a program like the one described here should be a required as part of the preparation for receiving and maintaining administrative certification to encourage and prepare our educational leaders with a clear understanding of what they are expected to lead.

References

Barbour, Andrew. (April, 1987). "Office romance: Why administrators are hooked on technology." *Electronic Learning.*

Beaver, John F. (April, 1988). *A national search for quality: An examination of high-quality elementary school instructional computing programs.* Unpublished dissertation, Michigan State University.

Bruder, Isabelle. (June, 1989). "NSBA study says largest districts have weak long-range technology plans." *Electronic Learning.*

Charp, Sylvia. (June, 1989). "Editorial." *Electronic Learning.*

Fulton, Kathleen. (October, 1988). "Preservice and Inservice: What Must Be Done in Both." *Electronic Learning.*

Kearsley, Greg (November, 1988). "What Should Today's Administrators Know About Computers?" *Technology Horizons in Higher Education Journal.*

Kinnaman, Daniel E. (September, 1989). "NEA committee on educational technology releases report." *Classroom Computer Learning.*

Langhorne, Mary Jo, Jean O. Donham, June F. Gross, Denise Rehmke. (1989). *Teaching with computers A new menu for the '90s.* Phoenix: Oryx.

McCarthy, Robert. (September, 1988). "Making the future work: The road to computer integration." *Electronic Learning.*

Moursund, Dave. (June, 1989) "Why are our colleges of education continuing to graduate computer illiterate teachers?" *The Computing Teacher.*

Scrogan, Len. (January, 1989). "The OTA report: Teachers, trainers, and technology." *Classroom Computer Learning.*

Thornburg, David D. (October, 1988). "A time to take stock of the state of educational computing." *A+ Magazine.*

Technology Competence Survey of Western NY Elementary Principals

The bold faced numbers next to each survey item indicate the percentage of the total respondents who selected that option. (61 of the 107 principals surveyed replied, for a 57% response rate.)

---

1. Do you have a microcomputer in your own office?
    - a) Yes **54%** b) No **46%**
2. Do you have a microcomputer in your home?
    - a) Yes **52%** b) No **48%**
3. How often do you typically use a microcomputer?
    - a) Seldom **48%** b) Several times each week **14%**
    - c) Daily **25%** d) Often each day **13%**
4. On average, for what period of time do you use a computer *each week*?
    - a) Less than 1 hour per week **48%** b) 1 to 5 hours per week **25%**
    - c) 5 to 10 hours per week **16%** d) More than 10 hours per week **11%**
5. How would you assess your own *personal computer competence*?
    - a) Nil (none at all) **20%** b) Little (turn machine on and off) **5%**
    - c) Some (competent with 1 or 2 programs) **29%** d) Adequate (competent 1 system) **29%**
    - e) Advanced (competent in several systems) **17%** f) Expert (broadly competent) **0%**
6. Have you taken courses in administrative applications of technology?
    - a) No courses **66%** b) 1 course **21%**
    - c) 2 courses **11%** d) 3 or more courses **2%**
7. Have you been provided training in microcomputer use for your job?
    - a) Yes **43%** b) No **57%**
8. Estimate the number of hours of training you were provided in the use of microcomputers at your job.
    - a) Less than 3 hours (one half-day session) **55%** b) 3 to 6 hours (one full-day session) **13%**
    - c) 6 to 12 hours (two full-day sessions) **18%** d) 12 to 18 hours (three full-day sessions) **7%**
    - e) 18 to 30 hours (3 to 5 full-day sessions) **4%** f) More than 30 hours **5%**
9. How many training hours in using computers to improve your professional competence would you attend *each year*?
    - a) Less than 3 hours (one half-day session) **13%** b) 3 to 6 hours (one full-day session) **16%**
    - c) 6 to 12 hours (two full-day sessions) **34%** d) 12 to 18 hours (three full-day sessions) **18%**
    - e) 18 to 30 hours (3 to 5 full-day sessions) **13%** f) More than 30 hours **7%**
10. How would you describe the process used to plan for your school's educational use of technology? Decisions are usually made:
    - a) Top-down **32%** b) By committees **52%**
    - c) Independently by individuals **7%** d) No planning process **9%**
11. How would you describe the place of educational technology in the budgeting process used by your school? Educational technology use is:
    - a) A permanent budget line-item **59%**
    - b) Primarily budgeted on an "ad-hoc" basis **29%**
    - c) Primarily funded by outside sources **13%**
12. How important do you believe that appropriate educational use of technology is to your school?
    - a) Of no importance **2%** b) Of little importance **4%**
    - c) Of considerable importance **30%** d)Very important **64%**
13. How satisfied are you with the present state of your school in terms of the educational use of technology?
    - a) Very dissatisfied **18%** b) Somewhat dissatisfied **43%**
    - c) Generally satisfied **30%** d) Very satisfied **9%**

For the next 6 questions, assess your own competence level in using these productivity-enhancing computer applications.

14. Word Processing
    - a) Nil (none at all) **21%** b) Some (enter, edit, & print text) **43%**
    - c) Advanced (format, spell check) **34%** d) Expert (styles, glossaries, TOCs) **2%**

15. Data Bases			
a) Nil (none at all)	**36%**	b) Some (enter, edit, & print data)	**46%**
c) Advanced (format, sort, search)	**14%**	d) Expert (use complex functions....)	**4%**
16. Spreadsheets			
a) Nil (none at all)	**59%**	b) Some (enter, edit, & print data)	**34%**
c) Advanced (functions, formulas...)	**7%**	d) Expert (use complex functions...)	**0%**
17. Charting			
a) Nil (none at all)	**71%**	b) Some (enter, edit, & print charts)	**25%**
c) Advanced (re-size, re-scale...)	**4%**	d) Expert (complex manipulations...)	**0%**
18. Telecommunicating			
a) Nil (none at all)	**70%**	b) Some (use E-mail in-house)	**18%**
c) Advanced (send & receive files)	**13%**	d) Expert (more complex uses..)	**0%**
19. Desktop presenting			
a) Nil (none at all)	**79%**	b) Some (create transparencies)	**18%**
c) Advanced (present with LCD)	**4%**	d) Expert (use LCD with memory module)	**0%**

For these questions on computer-related educational technologies, rate your own experience level:

20. Local Area Networks (LANs)			
a) Nil (none at all)	**59%**	b) Some (I've read about them)	**23%**
c) More (I've seen them used)	**13%**	d) Much (I'm knowledgeable about them)	**5%**
21. Integrated Learning Systems (ILSs)			
a) Nil (none at all)	**48%**	b) Some (I've read about them)	**34%**
c) More (I've seen them used)	**14%**	d) Much (I'm knowledgeable about them)	**4%**
22. Videodisc players			
a) Nil (none at all)	**36%**	b) Some (I've read about them)	**25%**
c) More (I've seen them used)	**34%**	d) Much (I'm knowledgeable about them)	**5%**
23. CD-ROM players			
a) Nil (none at all)	**43%**	b) Some (I've read about them)	**16%**
c) More (I've seen them used)	**34%**	d) Much (I'm knowledgeable about them)	**7%**
24. Liquid Crystal Display Devices (LCDs)			
a) Nil (none at all)	**70%**	b) Some (I've read about them)	**16%**
c) More (I've used them)	**7%**	d) Much (I'm knowledgeable about them)	**7%**
25. Hypermedia			
a) Nil (none at all)	**84%**	b) Some (I've read about it)	**9%**
c) More (I've used it)	**5%**	d) Much (I'm knowledgeable about it)	**2%**
26. Multimedia			
a) Nil (none at all)	**55%**	b) Some (I've read about it)	**25%**
c) More (I've used it)	**18%**	d) Much (I'm knowledgeable about it)	**2%**
27. Modems			
a) Nil (none at all)	**21%**	b) Some (I've read about them)	**48%**
c) More (I've used them)	**25%**	d) Much (I'm competent with them)	**5%**
28. Scanners and Digitizers			
a) Nil (none at all)	**55%**	b) Some (I've read about them)	**32%**
c) More (I've seen them used)	**13%**	d) Much (I'm knowledgeable about them)	**0%**
29. Facsimile Machines (Fax)			
a) Nil (none at all)	**23%**	b) Some (I've read about them)	**13%**
c) More (I've seen them used)	**38%**	d) Much (I'm knowledgeable about them)	**26%**

Paper (W1.4b)
Promoting a Broader Perspective on Computers in Careers

Valerie A. Clarke and G. Joy Teague
Deakin University
Victoria, Australia

Abstract

It is popularly believed that people who work with computers sit alone all day staring at a computer screen and have little or no interaction with other people. Women working in computing talk about the great variety in their jobs, the need to be constantly communicating with others and the satisfaction gained from solving problems for others. It appears that many girls are deterred from computing careers because they do not realize the true nature of these careers. A video featuring six women working in a variety of computing careers describes the women, their careers and the features of those careers. The video was well received by representative groups who viewed it, and preliminary results indicate that the inaccurate perceptions which girls have of computing careers are modified as a result of viewing the video.

Background

Why don't more women study computing? Across Australian universities women account for about half of undergraduate enrolment, yet only 25 per cent of first year tertiary computer science students are girls (Kay, 1990). Even fewer girls are enrolled in the second and third years of the courses. Similarly, at secondary level, the boys outnumber the girls in most computer science courses (Taylor, 1992). Why are the girls choosing Arts or Teaching rather than Computer Science?

In attempting to answer this question we collected interview data from 68 students enrolled in tertiary level undergraduate computer science courses and from seven women working as professional computer scientists. We were absolutely amazed to find that the students' views were all consistent with the popular stereotypes, but that the professional women all talked enthusiastically about their jobs in terms that sounded totally unrelated to anything the students said. Although the professional women, when students, had held similar views to the undergraduates, they have found the real world of employment very different from their expectations (Teague and Clarke, 1991).

Whereas the students talked about the time they spend learning to program and working alone with a computer, or the problems of gaining access to a computer, the professional women spend very little time working alone programming or dealing with technical problems. Much of their computer time is spent in writing rather than programming. They all noted the great variety in their jobs, the continual change in the nature of their work, the need to be constantly communicating with others, and solving problems for others. Essentially, they described a person-oriented job rather than a technical, mathematical or scientific one.

Similarly, while the students spoke of successes and failures in terms of writing programs or academic work, the professional women gained satisfaction from helping people and solving problems. Very few of them encountered failure or dissatisfaction, except to note that there was too much to do and too little time to do it to their personal standards.

When asked about the reasons for female under-representation in computing, both students and professionals spoke about the lack of encouragement and/or the lack of an opportunity to formally study or gain experience in the related areas of computing, math, science and technology. With the exception of two or three male students, most students considered that girls were able to be successful in computing, but that the girls believed they were unable to be successful, and/or that society did not provide them with the chance to be successful.

The professional women considered that there was an undue emphasis on the scientific, mathematical or technical side of computing. Several of them said that they actively avoided work in these areas, yet were always gainfully employed and derived a great deal of satisfaction from their work. While these subjects provided a good grounding for any computing career, they were not an intrinsic component of computing and can be avoided completely.

The students' suggestions for increasing the numbers of women in computer science focused on generally accepted ideas, such as teaching more computing in schools, encouraging girls' interest, changing the nature of computing courses, increasing the number of female role models, removing stereotyping, and making girls aware of the benefits of studying computing. However, the professional women did not see these as key issues. Rather, they believed that the greatest single reason for the lack of women in computing arose from the inaccurate perceptions students have of computing careers.

The professional women said the best way of attracting more students, and particularly girls, into careers in computer science, or using computers as tools in other jobs, is to provide printed materials and videos that present a more accurate view of the nature of work in this field to students who may suffer the popular misconceptions.

It was the suggestions made by these professional women that led to the application for financial support to make a video. Funding was provided by the Women's Grants Program, administered by the Office of the Status of Women, Department of the Prime Minister and Cabinet. Additional funding was provided from Department of Education, Employment and Training Equity Funding and from Deakin University.

The Video

In preparation for filming the video, twenty schoolgirls and twelve professional women were interviewed. Apart from a few comments from the schoolgirls about wanting to be vets to work with animals, they identified similar job characteristics, all of these being consistent with jobs using computers: variety, challenge, interaction with people, high salaries, satisfaction, and the opportunity to travel. When asked directly about using computers in their future careers, most of them had little or no idea about jobs using computers or of the role of computer scientists.

The twelve professional women all had a great deal to contribute, but to keep the video to a reasonable length, only six of these women were included in the video. However, it was decided to include the profiles of all twelve women in a booklet that accompanies the video. This material may be used by teachers to provide a basis for further discussion or in answering questions raised by students, or it may be reproduced for distribution to students who want information additional to that presented in the video.

The women in the video all talk about their own jobs in their own words. Only the presenter is a professional actress. None of the interviews was scripted. In the video, the presenter, a young female television personality, interviews each of the six women and asks them to describe the features of their jobs. The women work in a wide range of occupations, as the objective is to encourage all girls to study enough computing to feel comfortable with the technology at the level at which they might wish to use it, rather than to encourage girls to study computer science specifically. The interviews are interspersed with short segments where schoolgirls are asked what they think and/or know about computing. The combination of interviews and 'vox pops' provides a lively and interesting twenty-six minute program.

Rather than attempting to fully describe the work that the women do, the interviews provide only a short description of the jobs and concentrate on the features of those jobs that might attract more girls into them. These features include working with people, being creative, opportunities for travel, and high salaries. The descriptions of the women and the work they do, as they are introduced in the video by the presenter, are given below:

Sheryl Lumb of Micro-Energy. Sheryl manages a computer-based training group. She develops programs on computers for teaching lots of different things, from how the company works to how to use the company telephone system. She uses graphics and computers rather than relying on text books, which can get a bit tedious.

Caroline Coles of Deakin University. Caroline is a video editor at Deakin University. She is the person who edited this video. Caroline selects the best sections and puts them together to make an interesting program which flows and makes sense.

Amanda Keely of Mobil Oil. Amanda has a very important job at Mobil. She is a project manager. She is very hard to get to see as her work involves talking to other people a lot of the time, not as you might expect, working on a computer all day. Amanda is responsible for the teams of people who develop very large systems. They take several months or even years to complete.

Liz Scott of CSIRO. Liz is a user support consultant at CSIRO, which is a government funded research center. Her job is solving day-to-day problems that scientists have when working with their computers. She also helps them choose the right hardware and software for their work.

Cathy Loughrey of Synergy Software. Cathy works as a contract consultant systems analyst. Explaining what Cathy does is a challenge. She works with different companies, such as ANZ, Red Cross, and Cadbury-Schweppes. Cathy works out how to write programs that will let the people in the company use computers to do their daily repetitive work. To do this she has to understand how the company works and its needs. Cathy finds the work interesting and challenging.

Melinda Shackleton of Fletcher Jones. Melinda works in the fashion industry for Fletcher Jones. She uses a computer to draw patterns for all types of clothing. She works closely with a designer and a computer to make the job of pattern drafting and sizing more efficient.

The Accompanying Booklet

For the six women described above the booklet provides:

- the descriptions as they were spoken by the presenter and as are written above,
- their job titles,
- a detailed description,
- the backgrounds of the women,
- the features of their jobs, and
- advice to secondary students wishing to obtain a similar job in the future.

In addition, the six women who were interviewed but not included in the video are included in the booklet under the same headings. Their descriptions are:

Janine Stewart of Desktop Dynamics. Janine is self-employed as she runs her own private desktop publishing company. She has one other full-time member of staff and employs casual staff when she needs extra assistance.

Christine Rimmer at Home. Christine is an analyst-programmer. She works for a small private company. At the time she was interviewed she was on maternity leave, but has since returned to part-time work.

Michele Haywood of Micro-Energy. Michele is a trainer who spends her time teaching people, mainly women, about computer use and computer applications. She conducts commercial courses for industry.

Maree Nolan of Micro-Energy. Maree creates the graphics for training programs. She uses a scanner to read and load pictures into a computer. Sometimes she draws directly onto the screen using a drawing package and the computer mouse.

Sarah Learmonth of Mobil Oil. Sarah is an analyst programmer. She prefers analysis although she spends some time programming. Analysts produce specifications for programmers so they need a clear understanding of programming.

Charlie Chan in the Arts. Charlie is a self-employed music composer and producer. Although she has been in music for some time, it is only in the last few years that computer software has been sufficiently advanced to be able to be used for professional music.

Audience Response

The video was shown to three representative groups before being released:

- a group of computing academics and practitioners,
- a group of secondary school teachers, and
- a group of year ten girls, the target audience.

All three groups were unanimous in their praise. When the first audience of twenty year ten girls were asked to provide an anonymous comment on the video, the only comment that might be construed to be negative was 'A bit dizzy'. The others suggested:

(It was) really good/excellent	11
(It was) good/liked it	7
Interesting/entertaining/funny	6
It should be sent to schools/shown to (all) girls	5
Presenter stopped it being boring	1

The video has been shown to several school groups. Students in half of these groups completed a computer attitudes questionnaire before viewing the video and students in the other half of the groups completed the questionnaire after viewing the video. Preliminary results comparing the scores on the attitudes measure of students who had seen the video with those of students who had not seen the video indicated that the students' perceptions of computing careers have become more realistic as a result of viewing the video.

Conclusion

Girls are not attracted into computing because they perceive it as being an occupation that requires little interaction with others, and much time spent working at a computer. Women working in the field describe their jobs quite differently, and in glowing terms. If more girls are to be encouraged to consider working with computers they must be provided with information that describes the variety, diversity and challenge of computing careers. A video addressing this problem has been received very positively by representative groups who have viewed it.

References

Kay, J. Computer equity: Girls, women and computers. Presentation at the *Fifth World Conference on Computers in Education*. Sydney, Australia, 9-13 July, 1990.

Taylor, C. Contained in a report presented to the Victorian Curriculum and Assessment Board, Information Technology Field of Study, 1992.

Teague, J. & Clarke, V. Fact and fiction: Students' and professionals' perceptions of women in computer science. In I. V. Eriksson, B. A. Kitchenham, & K. G. Tijdens, (Eds.). *Women, work and computerization: Understanding and overcoming bias in work and education.* Amsterdam: North-Holland, 363-375, 1991.

Paper (W1.4c)
Labs, Learning Styles, and Gender

Cindy Meyer Hanchey
Oklahoma Baptist University
Shawnee, Oklahoma

Abstract

The reintroduction of a closed laboratory component to introductory computer science courses is mandated by recent curricula recommendations. It poses the interesting question of what relationships exist between closed labs, cooperative learning, and gender, if any. This paper examines the direction of computing curricula, defines learning styles and cooperative learning with a literature review of their relationships to computing, and discusses the gender issues relevant to this discussion.

Computing Curricula
Historical Perspective and Current Directions

ACM has published undergraduate computer science program recommendations in 1968, 1978, and now Computing Curricula 1991 (ACM, 1991). Other published curricula recommendations have been made for information systems undergraduate programs by both ACM and DPMA (the most current is DPMA's 1990 model curricula) (DPMA, 1990). While the two new curricula are designed for two different groups, there are both similarities and differences. One similarity is the change from course descriptions to knowledge content descriptions. An excellent comparison of the two curricula can be found in Owens (1992).

Curriculum 68 indicated that laboratory sessions were to be included to present the more practical aspects of the material in a manner that is more effective than formal lectures (ACM, 1968, p. 156). Mention of laboratory sessions gradually disappeared from the curriculum guidelines until the publication of Computing Curricula 1991 (ACM, 1991). Two distinct types of labs are described (1) open—unsupervised assignment that may involve use of a computer for completion and that may be completed by a student at his or her convenience, and (2) closed—scheduled, structured, supervised assignment that involves a computer for completion.

Laboratory experiences are also included in IS 90 (DPMA, 1990, p. 1). Recommendations are made for the inclusion of "supervised structured laboratory exercises" (DPMA, 1990, p. 8). According to Myers (1992, p. 179), many of these exercises encourage students to work in groups.

The Laboratory Component

By 1991, the focus on the laboratory component of the curriculum was apparent. Roberge (1991), Epp (1991), Chavey (1991), and Dalbey (1991) all describe laboratory models. Chavey (1991) listed lab goals as being (1) to help students become comfortable with the environment, (2) to use the labs to introduce programming details, (3) to use the labs to help students learn more details about some commands, (4) to teach the concepts of computer science, and (5) to try to include the use of experimentation and the student design of experiments as a significant component (Chavey, pp. 288-289). The design of the closed lab components of the introductory programming classes was intended to meet the needs of the beginning students and "to develop a laboratory atmosphere in which students consistently experience success with small, yet meaningful exercises" (Johnson, White, and Hendrix, p. 141).

Two panel presentations made at the Twenty-Third SIGCSE Technical Symposium in March of 1992 addressed the relationship between the introductory computer science course and the laboratory component. One panel (Allen, 1992, p. 317) focused on the practical issues of development and implementation of structured labs. The second panel (Turner, p. 322) discussed the design and content of the two introductory courses, quality and outcome evaluations in three different settings, and the summer workshop series. According to Tucker (personal communication) and McGregor (personal communication), the demand for the workshop was extremely high.

Learning Styles
Defined

"Learning style is composed of consistent patterns of how an individual begins to concentrate on, process, internalize, and remember new and difficult information" (Geisert & Dunn, p. 219). In other words, learning style indicates that each person learns through a wide variety of methods, and this occurs in a different manner for each individual. For example, one may be a visual learner, while another may prefer "hands-on" experiences (Stewart, p. 371).

An interesting area of research is that of the relationship between computer abilities and general cognitive processes (Evans & Simkin, p. 1322). According to Evans and Simkin (1989), "Important cognitive variables include those that measure the ability to (1) understand abstract concepts; (2) translate word problems into equations or other symbolic codes; (3) outline logic into steps; and (4) follow complex directions listed in a procedure."

Evans and Simkin (1989, p. 1323) describe twelve studies (1972-1987) that attempted to predict student computer proficiency. One concern was the difficulty in measuring cognitive processes. They used both the Myers-Briggs type indicator and a fourteen-question problem-solving test (Evans & Simkin, p. 1324). According to them, a separate type of personality can be associated with each of the sixteen possible combinations from the Myers-Briggs type indicators. They felt it reasonable to expect that some of these personalities would be better able to learn computer skills than others (Evans & Simkin, p. 1324).

A study by Davidson, Savenye, and Orr (1992) attempted to examine the relationship between learning styles as described by Gregorc's four abilities (concrete sequential, abstract sequential, abstract random, and concrete random) and performance on computer application tasks. They suggested that students who have a preference for step-by-step procedures may enjoy structured programming better than those students who tend to learn best through exploring (Davidson, et. al., pp. 350-351).

Effect on Programming Students

An examination of two types of learning styles, analytic and global, indicates one reason why some students might have difficulty with programming. Most computer programs are designed for analytic processors who think in a step-by-step sequential fashion. Global processors, on the other hand, try to understand the idea or concept first, then they work with the facts and details (Geisert & Dunn, p. 220-221). Analytics focus on details and will memorize if needed but are less concerned with the "why"; whereas, globals want (need) to understand why information is important prior to memorization (Geisert & Dunn, p. 221).

These two contrasting learning styles might hinder a student's learning of a programming language if the teaching were presented in a single manner without regard to style. Contrarily, a presentation of material focused on different learning styles could benefit the learner (Geisert & Dunn, p. 221).

Cooperative Learning

Defined

Cooperative learning (collaborative learning or small-group learning) is an alternative technique to traditional teaching in which students are divided into small groups (Manning & Lucking, p. 152). Manning and Lucking (1991, p. 153) provide an overview of eight cooperative learning methods that describes similarities and differences among the different techniques.

Historically, the traditional classroom has prepared students for a work environment of individualism and competition (Beckman, p. 128). As the world and work environments change from an industrial age to an information age, so must restructuring of teaching and learning occur (Boschee, p. 89). Current educational settings foster competition between students instead of learning cooperatively. Cooperative learning can add to academic achievement, social skills, and self-esteem. This is documented in the literature (Manning & Lucking, p. 152, Boschee, p. 89).

Instead of students' equating rewards and success with outperforming their competitors, learners achieved success as a consequence of listening to peers, helping and teaching each other, and helping others in the team to teach (Manning & Lucking, p. 154).

The studies also indicate that high, average, and low achievers benefit equally from the cooperative learning process (Manning & Lucking, p. 154).

Cooperative education can be used to increase both test performance and interest in the subject (Borresen, p. 26). In the Borresen study, students were divided into three groups. When performance was compared, voluntary groups performed better than assigned groups which performed better than the traditional structure (Borresen, p. 27). Attitude was measured both with formal class evaluations and informal class discussions. Small groups returned positive feedback (Borresen, p. 28).

Effect on programming students

According to Boschee (1991, p. 89), studies of the relationships between small groups and academic achievement have resulted in the following conclusions:

1. Cooperative learning experiences... promote higher achievement, greater motivation, and more positive attitudes toward the subject matter and the teacher.
2. The increased interaction in small groups apparently helps students to understand and remember...
3. Positive effects have been found on such higher-order objectives as creative writing, reading comprehension, and math problem solving...
4. Reflection, as enabled by cooperative learning, is the bridge between the concrete experience and the formal learning of relevant concepts. (Boschee, pp. 89-90).

These conclusions indicate the benefits of small group learning which a closed lab environment can supply. The complex issues of attitude (in particular, those of women toward programming and mathematical courses), comprehension and problem-solving, and learning style differences can be assuaged by the combination of traditional lectures and small-group learning in a closed lab.

If the results of the Borresen (1990) study can be extended to programming classes, then the performance of students should be improved by the use of small group learning.

Gender Issues

Background

Women and men have been raised differently and have been treated differently both in the educational arena and in the work place (Porat, p. 412). Gender differences include the following:

1. Females tend to prefer to take turns rather than to compete and will sacrifice winning for maintaining relationships. Men play to win.

2. Females are inclined toward facilitating leadership, delegation, encouragement, and gentle nudging. Men lead from the front taking a dominant position.

3. Females view communication as a bridge to understanding. They prefer contributory, consensual decision making. The focus of women is on the process and the path to get there. Men view communication as a means to get and maintain power. Their preference is for majority rule. They emphasize the product and the goal. (Porat, pp. 412-413).

Schools have continued to teach to groups rather than to individuals, but identification of individual learning style should permit individualized instruction. Learning styles show how groups are similar and/or different (for example, "how boys' styles differ from girls' styles") (Dunn, et. al., 1991, p. 94). Rather than ignoring these differences, computer educators can provide for the different learning styles by the utilization of both lecture and closed labs in the programming environment.

One encouraging report presents results of a project that developed alternative curriculum models and pedagogical approaches using the principles of mastery learning, small group and individualized instruction, peer tutoring, thematic studies, and broad motivational strategies (Nolan, et. al., p. 300). With the computer viewed as a resource tool, inequities related to ability, gender, and socioeconomic status disappeared (Nolan, et. al., pp. 310-311). When a supportive environment for women exists and the teaching component meets their learning styles, they will learn how to use computers and use them well (Nolan, et. al., pp. 312-313).

A large problem is that men drop out of math and science courses due to a lack of competence, whereas women drop out due to a lack of confidence—even though they could do the work (AAUW, p. 28). A similar problem in the computer science field, as well as in other math and science areas, is that women may be concerned about difficulty and competitiveness which are perceived as barriers to success (AAUW, p. 29).

Effects on programming students

Unfortunately, there is little research to be found regarding the effects on women of cooperative learning in a programming environment. Research studies have shown very positive effects on multi-cultural, ethnically diverse, and combined handicapped with non-handicapped groups by the use of cooperative learning (Manning & Lucking, p. 155). What is now needed are some long-range studies of the effects on women of cooperative learning introduced in closed labs associated with introductory programming courses.

Conclusions and Recommendations

The closed laboratory component of introductory computer science courses will become essential for any school complying with ACM/IEEE-CS or DPMA curricula recommendations. While implementation poses difficult problems in terms of staffing, course load for faculty, scheduling of lab facilities, and development of exercises/experiments, the potential benefits for students should be the overriding factor.

Three of the five main findings in a Harvard University study relate to this paper directly and are listed below (Light, pp. 8-9):

1. Gender differences in the college experience
   Four clear gender differences were found: women prefer a personal relationship with a faculty advisor or proctor; women are more likely to study alone, yet both men and women who formed study groups enjoyed the work more and felt they learned more; women are more self-critical than men; and women's satisfaction with their academic experience is more closely tied to their grades than men's (Light, pp. 17-20).
2. Characteristics of highly respected courses
   Quick and detailed feedback, ability to perform revisions, and frequent evaluations were the three essentials of a good course (Light, pp. 31-33).
3. Innovations by faculty and how students learn
   Faculty innovations that get students involved in "active learning" in small groups appear to create more significant learning (Light, pp. 9, 34, 39).

Using these findings, one can hypothesize that small group learning in a closed lab environment can improve women's attitudes toward computer science which in turn can increase women's participation in the field (AAUW, p. 72). The small groups established in labs can carry over to study groups for courses. The closed lab permits more personal one-on-one relationships between student and teacher which, in turn, encourages better communication (Golen and Keller, p. 8). Guided hands-on experiences may be more successful for women than a lecture approach (AAUW, p. 32).

Based upon these facts (structured labs will become an integral part of introductory computer science courses, learning styles of women differ from those of men, cooperative learning is beneficial to women and men alike), the only remaining question is will cooperative learning in a computer science lab encourage women to remain in the computer science field? Surely, this must be answered positively. One can consider this paper a call for research to verify this hypothesis.

References

AAUW Educational Foundation. (1992). *The AAUW report: how schools shortchange girls.* Washington, DC: AAUW Educational Foundation.

ACM. (1968, March). Curriculum 68, Recommendations for academic programs in computer science. A report of the ACM curriculum committee on computer science. *Communications of the ACM*, 11 (3), 151-197.

ACM. (1991, June). Computing Curricula 1991, A Summary of the CM/IEEE-CS joint curriculum task force report. *Communications of the ACM*, 34 (6), 68-84.

Allen, T. (Moderator). (1992, March). Issues in implementing structured laboratories for computer science. In the *Papers of the Twenty-Third SIGCSE Technical Symposium on Computer Science Education*, March 5-6, 1992, 24, 317.

Beckman, M. (1990, Fall). Collaborative learning: preparation for the workplace and democracy? *College Teaching*, 38 (4), 128-133.

Borresen, C. R. (1990, Winter). Success in introductory statistics with small groups. *College Teaching*, 38 (1), 26-28.

Boschee, F. (1991, November/December). Small-group learning in the information age. *The Clearing House*, 65 (2), 89-92.

Chavey, D. (1991, March). A structured laboratory component for the introductory programming course. In B. B. Owens (Ed.), The *Papers of the Twenty-Second SIGCSE Technical Symposium on Computer Science Education*, 23, 287-295.

Dalbey, J. (1991, June). Applying Zen principles in an introductory programming course. *SIGCSE Bulletin*, 23, 21-23.

Davidson, G. V., Savenye, W. C., & Orr, K. B. (1992, Spring). How do learning styles relate to performance in a computer applications course? In Spuck, D. W. and Bozeman, W. C. (Ed.) *Journal of Research on Computing in Education*, 24 (3), 348-358.

DPMA. (1990). *Information Systems: The DPMA Model Curriculum for a four year undergraduate degree*. Park Ridge, IL: DPMA.

Dunn, R., Shea, T. C., Evans, W., & MacMurren, H. (1991, November/December). Learning style and equal protection: the next frontier. *The Clearing House*, 65 (2), 93-95.

Epp, E. C. (1991, March). An experimental computer science laboratory. In B. B. Owens (Ed.), *The Papers of the Twenty-Second SIGCSE Technical Symposium on Computer Science Education*, 23, 11-14.

Evans, G. E. & Simkin, M. G. (1989, November). What best predicts computer proficiency? *Communications of the ACM*, 32 (11), 1322-1327.

Geisert, G. & Dunn, R. (1991, March/April). Effective use of computers: assignments based on individual learning style. *The Clearing House*, 64 (4), 219-224.

Golen, S. & Keller, T. (1987, Fall). Identifying communication barriers in a computer laboratory environment. In J. A. Horn (Ed.), *The Journal of Computer Information Systems*, 28, 8-9.

Johnson, R. D., White, R., & Hendrix, D. (1992, January). Introductory course lab exercises. In J. G. Meinke (Ed.), *Proceedings of the Fifth Annual Southeastern Small College Computing Conference*, Nov. 1-2, 1991, 7, 140-146.

Light, R. J. (1990). *The Harvard assessment seminars, explorations with students and faculty about teaching, learning, and student life*. Cambridge, MA: Harvard University.

Manning, M. L. & Lucking, R. (1991, January/February). The what, why, and how of cooperative learning. T*he Clearing House*, 64 (3), 152-156.

McGregor, J. (1992, June). Personal communication. Department of computer science, Clemson University, Clemson, SC.

Myers, W. (1992, January). IS '91—DPMA's latest curriculum model. In J. G. Meinke (Ed.), P*roceedings of the Fifth Annual Southeastern Small College Computing Conference*, Nov. 1-2, 1991, 7, 178-184.

Nolan, P. C. J., McKinnon, D. H., & Soler, J. (1992, Spring). Computers in education: achieving equitable access and use. In D. W. Spuck and W C. Bozeman (Eds.), *Journal of Research on Computing in Education*, 24 (3), 299-314.

Owens, B. B. (1992, June). Building a combined IS/CS curriculum by comparing Curriculum '91 and IS '90—is it possible? Draft report presented at NECC '92 session entitled Impact of ACM/IEEE Curriculum '91 and DPMA IS '90 on Computer Information Systems Programs in Small Colleges.

Porat, K. L. (1991, July/August). Women in administration: the difference is positive. *The Clearing House*, 64 (6), 412-414.

Roberge, J. (1991, March). Embedding laboratories within the computer science curriculum. In B. B. Owens (Ed.), *The Papers of the Twenty-Second SIGCSE Technical Symposium on Computer Science Education*, 23, 6-10.

Stewart, W. J. (1990, April). Learning-style-appropriate instruction: planning, implementing, evaluating. *The Clearing House*, 63 (8), 371-374.

Tucker, A. (1992, April 9). Personal communication. Department of computer science, Bowdoin College, Brunswick, ME.

Turner, A. J. (Moderator). (1992 March). The first two courses and laboratories: early experience with introducing breadth. In the P*apers of the Twenty-Third SIGCSE Technical Symposium on Computer Science Education*, March 5-6, 1992, 24, 322.

Projects (W1.5)
Multimedia

Multimedia Science for Students With Special Needs

Blanca Aguilar
Los Angeles Unified School District
Los Angeles, CA

Abstract

The Special Day Class receives students with different disabilities and learning modalities. Many of these students are unsuccessful in the regular curriculum. By using HyperCard the teacher has been able to create a learning tool that has raised the student's motivation and allowed them to have a successful educational experience. HyperCard provides students with the following: versatility, enhances the instructional connection between reading and writing through various modalities, students gain a sense of control and empowerment leading to success, allows for non-threatening trial and error experimentation, and personalizes instruction.

This multimedia presentation will share a HyperCard stack, "OUT OF THIS WORLD", created by the presenter and her class. It is geared for bilingual students with Learning Disabilities in the elementary school. This science stack ties other strands of the curriculum and utilizes a Macintosh computer, HyperCard software, video player, and a Laserdisc player.

Educational Electronic Networks and Hypertext: A Message Assistant for Distributed Learning Environments

James A. Levin
Michael Jacobson
University of Illinois
Champaign-Urbana, IL

Abstract

As electronic networks become more common and easier to use, people suffer from an overload of messages that can inhibit the effective participation in distributed learning environments. In our studies of educational uses of networks, we have found that our participants need more powerful tools for handling the mass of messages that they send and receive. We will describe a set of tools that we have developed, embedded in an electronic mail front-end called *The Message Assistant*. The tools include message handling rules and hypertextual message organizing tools. The rules provide a "hypertextual engine" for automatically adding hypertext structure to incoming and outgoing messages, allowing people to turn their message sets into knowledge bases. We will report data from the use of these tools by K-12 teachers and students, university faculty, undergraduates, graduate students, and adults outside the educational system, all engaged in joint network-based projects.

Students Dedicated To Learning Through Music And Technology

Fred Polansky
Burdick School
Milwaukee, WI

Abstract

At A.E.Burdick School in Milwaukee, Wisconsin, students use the latest computer technology to successfully integrate music throughout the entire curriculum. Through a Crossroads Education Grant from Apple Computer, Inc., students of diverse racial and economic backgrounds work together to create, compose, and synthesize music with original lyrics through the use of specially designed computer workstations, peripherals, and music software . The Macintosh computer "replaces" the teacher in a traditional music class through a "Music in Education™" lab. Trade and Technology classes build a digital drum set to be used by students in a MIDI music lab. Students use CD-Rom and laser disc to enhance learning, while both teachers and students in an English class contribute song lyrics to be included in original student musical compositions produced on Macintosh computers. Student generated multimedia projects are encouraged which encompass music, digitized audio and video, and actual live performances. Traditional academic curriculum is neatly blended in every classroom through a collaborative program between Burdick and the Milwaukee Symphony Orchestra. Along with technology unheard of only a decade ago, this newfound knowledge spreads throughout the school as students and teachers are drawn into an irresistible web of learning and discovery.

SMART Kids: Developing Teacher Resources

J. Fred Schouten
Tri-County Education Service Center #10
Channahon, IL

Abstract

Teachers would like to use the magic of technology in their classrooms, but they are either too busy to develop presentations or they do not have the skills to develop such products, These were the basic assumptions underlying the Student Multimedia Authoring Resource Training (SMART) project at Tri-County Education Service Center in Channahon, Illinois. Another assumption was that students can serve as valuable and willing resources for teachers in the development of these kinds of technological instructional aids.

In the pilot project, teams of students attended six days of training with a cooperating teacher from their school. Teams received instruction in communication skills, lesson design, storyboarding technique, and MacroMind Director™ (a multimedia authoring solution). For a final project, the teams worked with a content teacher from their school, and cooperatively designed a multimedia presentation for that teacher in that content area.

The sophomore level of high school was targeted in this project because it was felt that these students would be mature enough to work with teachers locally to cooperatively design lessons and presentations, and once they were trained in this process, they could then serve as a resource to teachers in their school for the next two years. Informal follow-up studies with the cooperating teachers over the last two years have indicated that the teams are using their skills to work with teachers in their local schools, and they are received as a non-threatening and welcome resource by these teachers.

Projects (W1.6)
Teacher Training

Large Scale District Training– A Train the Trainer Approach

Candy Egbert and Robert Dycus
Tucson Unified School District
Tucson, AZ

Abstract

Tucson Unified School District (TUSD) is implementing a 38 million dollar instructional technology project funded by bonds. Technology being purchased provides teacher workstations, library research stations, demonstration projects, and labs with tool software for learning in all content areas, including writing, science, and production. TUSD is a K-12 district with 104 schools, 3,373 teachers, and 57,705 culturally diverse students.

Many aspects necessary for a successful technology training program in a large district will be discussed. This large scale training program was established with Chapter 2 Block Grant funds to ensure a successful implementation of the instructional technology bond project. The presentation will be conducted by two project trainers describing a train the trainers model for initial and ongoing support. A technology contact person from each school site meets with the Chapter 2 training team on a regular basis for training and encouragement. They in turn train teachers within their school building. Other training activities will be discussed including a TUSD/ community college partnership.

Training guides and lesson plans which integrate technology in curriculum instruction will be available for distribution and/ or review.

Teaching Desktop Publishing: A Collaborative Approach

Julie Furst-Bowe,
University of Wisconsin-Stout
Menomonie, WI

Abstract

This summary describes a curriculum development project which is currently being implemented in the desktop publishing course at the University of Wisconsin-Stout in Menomonie, Wisconsin. The desktop publishing course, which is offered by the Communication, Education and Training Department, is a required course for students in several majors and an elective course for several other programs. In the fall of 1992, the instructors agreed to try a collaborative approach, which would involve students working with each other and working with others on campus in creating, designing and producing the final projects. The instructors would ask faculty and staff on campus to provide "projects" for the desktop publishing course. These projects could be brochures, newsletters, instructional materials or other printed materials which could be created by the students in the desktop publishing course and then printed and distributed on campus and in the community. At this time, the collaborative approach appears to be successful. A number of projects have been accepted and students are learning the basic steps in planning and producing publications. They are also learning to work with clients in a professional setting. In summary, this presentation will focus on curriculum development for desktop publishing and teaching desktop publishing using collaborative methods.

Using Interactive Videodisc Technology for Elementary Teacher Training

Carol Scott Whelan, Mary Jane Ford and Anne Fontaine
University of Southwestern Louisiana
Lafayette, LA

Abstract

Our latest project in the USL Educational Technology Review Center involves university faculty and students, area public school teachers and students, and business and community leaders in the production of a level one interactive videodisc on the teaching of probability at the fifth grade level.

Multimedia suggests a powerful innovation for classroom instruction. This project details the preparation and use of a multimedia instructional tool in the area of elementary mathematics. In the National Council of Teachers of Mathematics' *Curriculum and Evaluation Standards for School Mathematics*, 1989, Standard 11 for grades 5-8 states: "In grades 5-8, the mathematics curriculum should include explorations of probability in real-world situations…"The videodisc utilized was pressed from video tape of a student demonstration lesson on probability that preservice and inservice teachers will use and evaluate. Entitled *MathWorld/MathWorld,* the mathematics lesson was prepared by USL education students. The videodisc has been used by both undergraduate and graduate students in mathematics methods courses along with a HyperCard stack. Student evaluations of the interactive videodisc presentation indicate that this approach for training preservice is useful and would like to have access to a greater variety of lessons to choose from.

The videodisc *MathWorld/MathWorld* not only addresses the effective teaching skills and mathematics content; it provides a new approach for teacher training in the content area along with instruction in the use of interactive multimedia.

Teacher Education: Retooling With Technology

R. Michael Smith
Weber State University
Clearfield, UT

Abstract

The Utah State Legislature recently approved legislation, the Educational Technology Initiative (ETI), that provides 45 million dollars over a four year period to integrate technology into the public schools. University Colleges of Education receive a portion of this money for two specific reasons: first, to insure that preservice teachers are trained to use technology found in the schools, and second, to provide inservice teachers with knowledge and skills for integrating technology into classrooms. This presentation will describe how Weber State University has infused technology into its teacher education program to meet these two challenges.

Given the intent of the legislation, the College of Education began to expand its programs to meet these challenges. Weber State University's Teacher Education department is responding to the ETI in four ways:

1. Establishing an Education Technology Center
2. Training Teacher Education department faculty
3. Development of inservice training for public school teachers
4. Revising the teacher education program

The presentation will conclude with an overview of workshops that have been developed to meet Weber State University's Educational Technology Initiative goals.

This project is not currently a commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Projects (W1.7)
Instructional Software

The Magic of Parental Involvement with Technology

Tammy Havens, Roxanne Greco Butler, and Vanessa Cunningham
K.B. Richardson Computers Unlimited Magnet School
Kansas City, MO

Abstract

Parents of students at K. B. Richardson Computers Unlimited Magnet School have perceived a vast difference between their child's technological education and their own. The students are exposed to a highly-technical atmosphere, where they have access to approximately 380 computers, telecommunication networks, CD-ROM, robotics, and computer programming.

Therefore, parents have sensed a need to become educated concerning technology. In anticipation of this need, K. B. Richardson Computers Unlimited Magnet School created adult computer education classes.

The parents enroll in Introduction to Computers I and II classes, which are taught after school. The curriculum includes an introduction to keyboarding, word processing, graphics, database, and multimedia. Part of the curriculum utilizes programs that the students themselves use at the elementary school.

At its inception, classes were taught twice a year for parents, community members, and staff. The classes have been in such demand that the courses are now taught in several sessions year-round.

The Compufer As A Learning Integrator: Toolbox for Lifelong Learning

Stan Silverman and Gene Silverman
New York Institute of Technology
Central Islip, NY

Abstract

Building on models and strategies developed over the past four years in educational technologies, the Computer As A Learning Integrator (CALI) model enhances the study of science and math for students by promoting computer technologies as integral to the process.

At the core of integrating the computer to teaching and learning is the concept of a TOOLBOX For Lifelong Learning and Teaching. The TOOLBOX contains: word processing, spreadsheet, database, telecommunications, modelers, and presenting software (multimedia, HyperCard) skill development. The process of developing and delivering these tools for students and the lessons for content delivery is a result of teacher development. It is only when teachers experience the computer as a teaching integrator that they can then transfer those possibilities to students as a learning integrator.

A focus theme helps to give the initiative solid content in which to develop skills (the environment, for example, is a popular and rich topic for development). Activities move through a progression of skill building in technologies, science and math that are complementary to the school curriculum. Activities, sequencing, and projects are designed by teachers during development and training institutes. Specialists in the science or math content area and in TOOLBOX technologies participate in the development as well as provide training and support for teachers.

Specific strategies for replication and implementation will be presented.

Welcome, Aliens! Promoting Earth to Out-of-this-World Tourists

Lottie J. Simms
1992 State of Florida Instructional Computing Teacher of the Year
Dade County Public Schools
Davie, FL

Abstract

Through interdisciplinary strategies, students produce a book promoting tourism to Earth while learning the skills of writing, illustrating and publishing. The students work in cooperative learning groups to come up with a title for their book, a publisher, and a price at which to sell their book. They use graphics packages or programming skills to illustrate their book. They also use an integrated software package to promote and manage the selling of their book on the nine planets. All books include a title page and a credits page as well as a copyright date, publishing company and an ISBN number. A map and a sales report of the selling of their books is also included.

The project has been taught in a computer lab setting but can be easily adapted to the traditional classroom. The project requires word processing software and a variety of commercial graphics packages or a programming language easily suited to graphics concepts (BASIC, Logo). Art supplies are needed to assemble the book. These include construction paper, glue, and scissors. Solar system maps and imaginations are also highly recommended.

This IMPACT II grant award winning, original project has been proven to raise students' attendance levels as well as their skills in creative writing and computer applications. Students enjoy coming to class to write! They develop team skills by working in groups and develop responsibility for their individual tasks within that group. Through the project, skills in problem solving, writing, listening, science and social studies are reinforced. However, pride is most strongly developed upon completion of the project.

The presenter of this project is the 1992 State of Florida Instructional Computing Teacher of the Year. This presentation will focus on one of the projects that made her the award winner. The participants will receive the entire project package including lesson plans and resource ideas and alternative assessment strategies. Session participants will also be given the opportunity to view and respond to student samples and statistics.

Projects (W1.8)
Computer Science

Get the "H.O.T.S."! Cooperative Learning Methods in Computer Science Classes

Jill Jones and Theresa Cuprak
Carl Hayden High School
Phoenix, AZ

Abstract

Cooperative learning methods have often been used to enhance student learning and to encourage student participation. Two years ago we started using cooperative learning methods in our computer classes. We found that our cooperative assignments also increased our students' higher-order thinking skills (H.O.T.S.). We have been able to incorporate group activities in all of the computer classes we teach, from freshman-level Computer Science to Integrated Software and Advanced Programming.

Every year we think of new group activities and reuse the successful ones. Our activities include creating newsletters, writing programs that tell an interactive story, slide show presentations, radio or television broadcasts, music programs, writing game programs, creating a business, and making evaluation forms. These projects use analysis, synthesis, and evaluation, which Bloom has identified as higher-order thinking skills. Our projects also require research-skills, intuitive expression, creative writing, and visualization skills. These skills are identified as higher-order thinking skills by Frank Williams.

We would like to share some of these activities with other teachers so that they may also use our ideas or develop activities of their own. Our group assignments can be used in any kind of lab setting and with any number of computers.

The Computer Selection Game

Carl Stafford
Purdue University
W. Lafayette, IN

Abstract

This session describes a game on selecting a computer system. This game is used as a practical example of applying the information given in the lectures on selecting a computer system in a computer literacy course. The students are divided into teams with four to five students on a team. Each team is given the same set of instructions specifying the minimum acceptable system and the way points can be earned. These extra credit points are offered for meeting and exceeding the criteria in the instructions. Points are also subtracted to penalize a team that exceeds the specified amount. The criteria are restricted by the maximum price that can be paid and by the minimum computer system that shall be purchased. The maximum amount has remained at $2,500. The computer system has always been composed of the computer, keyboard, monitor and interface card, and a printer. However, the criteria for the computer and monitor have changed over time to reflect the level of the technology that is currently available. The computers are selected from a current copy of the *Computer Shopper* using an information sheet that the students must fill out.

The "New" Computer Literacy

Sharon Yoder
University of Oregon
Eugene, OR

Abstract

For the past 10 to 15 years, educators have struggled with the meaning of the term "computer literacy." With the enormous change in software and hardware that has occurred over this period of time, it seems appropriate to rethink the meaning of this term. In today's world—for students, teachers, and adults in our information age—the ability to make use of the power of desktop computers is central. Computer literacy is no longer about how computers work, how to write computer programs, the parts of a computer system, or even how to run applications programs. Rather computer literacy is about communication. This communication can be divided into six areas:

- Personal productivity—communications of information for oneself
- Communication using hypermedia—nonsequential presentation of material in an electronic form
- Communication using desktop publishing—presenting information on paper
- Communication with the computer as a presentation tool—displaying electronic "overheads"
- Communication using multimedia—using a variety of media driven by the computer
- Electronic communication at a distance—using networks, remote databases and electronic mail

This presentation will explore this definition and its implications for how we teach what we teach about technology.

Projects (W1.9)
Telecommunication

Effective Curriculum Integration of the Global Student Telecommunications Work: The I*EARN Experience

Edwin Gragert and Peter Copen
International Education And Resource Network
The Copen Family Fund, Inc.
Yorktown Heights, NY

Abstract

This project presentation will share with NECC participants exciting new international developments in I*EARN (the International Education And Resource Network):

- models of teacher training, including software simulations of on-line telecommunications work developed by I*EARN
- exemplary student projects completed through the I*EARN telecommunications network worldwide and integrated into the local school curriculum
- hands-on experience in global networking with K-12 educators

This project presentation and the I*EARN telecommunications network are neither commercial products nor ventures.

This abstract was taken from the author's originally submitted proposal

Complimentary Video and Data Networks

Beth Lowd
Massachusetts Corporation for Educational Telecommunications
Cambridge, MA

Abstract

Massachusetts has a growing telecommunications network that uses voice, video, and data links to connect its many school districts to each other and to the world. The combination of technologies makes possible co-teaching between experts in a studio and teachers in a distant classroom, idea sharing at any time of night or day, and bringing into the school and classroom both data and video resources that teachers could not afford to access in traditional ways.

It also connects students and teachers with their peers and with presenters from the video/voice network, the Mass LearnPike. MCET's main business is broadcasting via satellite live, interactive distance learning modules to the schools. For most live TV, you have either to flex the schedule so you can be in a viewing site at the right time, or to tape and lose the interaction. The Mass LearnNet makes it possible, however, for participants to interact over the computer network, at their convenience, between sessions. Thus they can extend a conversation begun on air or start one they think of between shows.

And what conversations! Imagine your students talking with a scientist from the zoo, a member of the Boston Ballet, a Nobel Prize-winning scientist, or students from all around the country. The Mass LearnPike offers learning modules for teachers and students in all curriculum areas, all live and interactive, so you can speak over the telephone with the people on the screen.

Finally, the video/voice network comes in very handy for training school people to use the computer network. MCET has done several programs, with excellent close-ups of screens, that our computer users swear by as training tapes. Moreover, several of our series this year will treat topics such as the Internet, or how to use telecomputing in general.

The two networks are very complementary, supporting each other and all kinds of communication for our member schools.

Projects (W1.10)
Practical Issues

Developing a College General Education Requirement Promoting Computer Literacy

William Boles, Jim Carraway, and Donald Hall
Manatee Community College
Bradenton, FL

Abstract

The need for computer literacy is driven by the proliferation of computer usage in all academic disciplines. The complexity of implementing a general education requirement for a computer fundamentals course in undergraduate programs requires substantive academic and administrative study. Course development concerns need to focus on academic relevance, costs of implementation and creation of evaluation criteria.

Since adoption of the three credit computer literacy requirement by Manatee Community College several positive outcomes have been observed. These include: 1) greater computer usage by students in other courses for projects and papers and 2) greater computer usage by professors in their courses for demonstration and out-of-class assignments. Negative impacts noted include changes in full/part time ratios (e.g. greater use of adjunct professors). Observed indirect results include: 1) a change in maturity level of students in the course and 2) an apparent lower level of commitment to academic achievement in the course. Growth does not come without a price *—the Ying and Yang of growth.*

To date, few institutions have fulfilled the recognized need for computer literacy across all disciplines. The procedures, cost/benefit factors, and academic considerations of incorporating a computer literacy course into the general education curriculum are factors that have been studied in this project.

Designing Classes For Teachers New To Technology

Georgia Brousseau and Virginia Griffis
Tucson Unified School District—Chapter 2
Tucson, AZ

Abstract

Tucson Unified School District (T.U.S.D.), a large urban school district, addresses the challenge of providing technological education for its teachers. The demand for more computer knowledge has rapidly increased as computers have become readily available in the district.

In a cooperative effort with a community college, the District's Chapter 2-Instructional Technology Training develops and offers classes with college credit for its teaching personnel. The class designs encourage integration of curriculum with technology. The participants learn methods of using the classroom workstations and the network labs as extensions and integral parts of their curriculum. In addition, the District offers one-shot mini workshops to its staff, focusing on step-by-step student centered, integrated lessons. This on-going education increases the meaningful use of technology in delivering instruction.

This presentation shares the philosophical basis and time frame in which the demands for classes and technological knowledge have evolved. It provides descriptions of classes promoting an interdisciplinary, tool-based, productivity oriented approach, and shares samples of student created, cross-curricular, computer generated projects—the products of this teacher education.

HELP! CPU For The Computer Phobic

Debra Freedman
New York City Board of Education
Brooklyn, NY

Abstract

Imagine how frightened, intimidated, and humiliated we would feel if we were asked,"How much RAM, ROM, MEMORY, or KILOBYTES do we have?" and didn't know the answer. The mention of these words creates panic in some people. This panic occurs in many who are "adults in transition students" going back to college to earn a degree for a career change in business. Many deny the fear, but feel insecure without computer knowledge.

The adult students at St. Joseph's College in Fort Greene, Brooklyn consist mainly of nurses and New York City police officers. The course is six weeks, meeting once a week for six hours on Saturdays.

The objective is to create a "user friendly" environment that eliminates computer phobia. This is accomplished through hands-on, positive reinforcement, and individualized instruction starting from the first class and continuing until the last class which is the sixth week.

This course demonstrates the parts of the computer (hardware) and their functions, as well as the hardware needed for using application software. Part of the course is devoted to evaluating application software programs; this allows the students to understand what is available for resume and report writing, file management, accounting, graphics, etc. Collaborative learning and peer tutoring are effective methods for this activity.

A videotape of the computer class showing hands-on will be shown. Sequenced lesson plans will be provided.

This is a class project and a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Development and Design of Interactive In-Service Training for Rural Social Workers

Sabrina Su-Fen Chin, Cia Verschelden, Kevin M. Kramer, Bebbie Folse, Linda Thurston, and Janice Denning
Kansas State University
Manhattan, KS

Abstract

In-Service training for social workers in rural areas presents challenges that involve low numbers, travel time and costs, and paucity of other resources. A survey of rural social workers in Kansas demonstrated a need for current information about regulations and professional issues. The respondents also noted the need for training which was interesting, current, and easily accessible. Multi-media computer and video-disc technology is an innovation for staff development which meets the needs of rural social workers.

This presentation will describe the needs survey and the resultant project which is using technology to meet these unique needs. The technology will be demonstrated and the development of a needs-based curriculum to be delivered by multi-media will be described. Development issues of navigation, learner control, and assured success in individualized training of non-computer literate trainees will be discussed.

This interactive videodisc-based instruction used in a curriculum development project, is a joint effort between the Social Work Program and the Department of Special Education at Kansas State University, a land-grant University in rural north central Kansas. The purpose of the curriculum is to provide in-service training for rural social workers to develop skills for working with children and families. The first unit, which represents one videodisc and a floppy with the instructional program, is about child development and is meant to teach social workers about normal and at-risk development. The unit also focuses on special education laws and definitions, assessment information, and workings as members of a multi-disciplinary or trans-disciplinary team.

Projects (W1.11a)
Curriculum Integration

The Computer as a Teaching Tool in Secondary Mathematics

Doug Brumbaugh
University of Central Florida
Orlando, FL

Abstract

Examples of lessons typically found in a secondary program will be demonstrated, using concepts that could not normally be achieved by traditional methods. IBM produced software will be used, but the examples can be duplicated on any symbolic manipulator, function plotting capable software.

Using the Mathematics Exploration Toolkit in the Secondary Mathematics Classroom

Charles E. Lamb
University of Texas at Austin
Austin, TX

Abstract

Lamb (1991) called upon the *Curriculum and Evaluation Standards for School Mathematics* (NCTM, 1989) and the *Professional Standards for Teaching Mathematics* (NCTM, 1991) to make a case for inclusion of appropriate technology in the mathematics classroom. The Mathematics Exploration Toolkit from the IBM Corporation is an award-winning piece of software which provides teachers and students with powerful tools for the study of mathematics at the secondary school level. Among the capabilities of this software are: high-speed calculation; symbol manipulation; and graphing.

As an example of the high-speed calculation, consider the expression, x^2-x+41. When values of x that range from 1 to 41 are substituted into the expression, simplification yields a prime number. However, when the value of 41 is used for x, the expression simplifies to a number which is a perfect square. The ability of the computer and software allows students to explore interesting relationships in mathematics without the tedium of laborious paper and pencil calculations.

The Mathematics Exploration Toolkit has excellent graphing capabilities. For example, using different colors, one may graph the following expressions: y=sin(x); y=e^x; and y=sin(e^x). By displaying all three graphs at once, the teacher is able to discuss many important mathematical concepts. In addition, there is a great time-saving advantage for the class.

The symbol manipulation component of the software allows the student and teacher to consider important attributes of problems without the need to spend large amounts of time in doing algebraic manipulations. If one considers the expression y=x^5-x^4-5x^3+5x^2+6x-6, it is quite difficult to graph, factor, and determine roots using traditional methods. *The Mathematics Exploration Toolkit* assists by quickly graphing and factoring. In addition, "zoom-in" features allow the approximation of roots to several decimal places.

These are but a few of the possibilities for the use of technology in the mathematics classroom. There are many pieces of hardware and software which are appropriate for classroom use. Educators should employ them whenever they assist in the learning of mathematics.

The Pride of Publication: Teachers Make Their Own Books

Elizabeth Anne Viau
California State University, Los Angeles
Los Angeles, CA

Abstract

Practicing teachers enrolled in a quarter-long computer literacy class made their own books using Macintosh and MicroSoft Works. Despite having had no computer experience prior to the class, the teachers developed pride and a sense of ownership in these final class projects. They astonished themselves and left the class with high morale, a sense of pride, and confidence in their computer competence.

The teachers developed their word-processing skills over the ten week period by taking their class notes on the computer each week and making a one page newspaper. The students' obvious enthusiasm suggests that assignments that allow personal creativity and ownership provide good experiences for students and a good participatory model of computer use by teachers.

Will the Nintendo Generation Read Books on a Computer Screen?

Jeri Wilson
The Voyager Company
Santa Monica, CA

Abstract

Believers claim that because computers are still a novelty, kids find it more interesting to read off a computer screen. Electronic text is more fluid, easier to manipulate, giving the reader more responsibility for their learning. It engages students by giving them the power to manipulate text and link visual and/or audio events to it, thereby creating multimedia book reports. It's simply a lot more fun.

On the other hand, it's difficult to read off of most screens. After the novelty wears off, how do we sustain the activity? How do we get them hooked—beyond the browsing mode? The jury is still out. Come share your thoughts with the believers and the skeptics.

Projects (W1.12)
Educational Software

WINCORP: The Wickliffe Interactive Network for Computers on Real Problems: An Innovative Cross Curriculum Project

Richard Benz, Alex Bezjak, Chris Capaso, Pat Coil, and Judith Palermo
Wickliffe High School
Wickliffe, OH

Abstract

This presentation will consist of the introduction and demonstration of a rather innovative curriculum model that has been developed at Wickliffe High School. The school received a $125,000 Apple Crossroads II grant to establish a cross curriculum, problem solving corporation called WINCORP. WINCORP or The Wickliffe Interactive Network for Computers on Real Problems involves students from science classes (biology), social studies (Introduction to Social Studies), mathematics (calculus), English (9th Grade Honors), and Art (9-12). The students were organized into research teams. Each team has scientists, social scientists, statisticians, writers, and illustrators working together to develop monographs about assigned topics. This presentation will describe how the Apple grant was won, how the networked computer system was set up, and how networked computers are helping these integrated high school students learn to communicate and how to solve real-life problems. An added bonus will be an overview of how Wickliffe High teamed up with the Lubrizol Corporation in this exciting project.

The major objectives for this presentation will be to showcase a very innovative integrated curriculum project that is teaching high school students how to use the newest technology to solve (or investigate) real problems. The presenters will describe the methods used to develop the grant proposal, and how the project was actually set into motion. Many of the most successful components of the project will be highlighted. The various high tech tools will be discussed (CD-ROM, HyperCard databases, telecommunication tools, desktop publishing, etc.). Finally, the participants will leave with the information necessary to develop their own integrated problem solving network and how to form partnerships with local businesses and industries to teach project management skills as well as problem solving skills.

Writing, Content, Computers Converge: The Alaska Writing Project

Heidi Imhof
Yukon-Koyukuk School District
Fairbanks, AK

Abstract

The *Alaska Writing Program* is a writing tool designed to help the reluctant or inexperienced writer discover *what goes where* in a variety of different writing tasks. The program adapts the process approach to writing—prewriting, revising, proofing, and publishing activities—to a writing environment on computer. The AWP software can be customized for use in any content area that requires writing or thinking. The software is available in Macintosh, Apple IIe/GS, and IBM (under construction, but should be ready by NECC) versions. Come see this software in action and learn how your school district can get a site license for this powerful tool.

The Alaska Writing Program is currently a non-commercial product/venture.

This abstract was taken from the author's originally submitted proposal

Old-Fashioned Print and Newfangled Technology: Whole Language for the '90s

Peggy Healy Stearns
State University of New York/Buffalo
Glenwood, NY

Abstract

Children today are growing up in a new age of communication. They spend much of their time listening to music, playing Nintendo, and watching television, movies, and videos. They have grown accustomed to high-resolution graphics, stereophonic sound, and dynamic video. These children come to the classroom audio and visually oriented. How can educators take advantage of these skills and use them to support and extend traditional print-based learning experiences?

Technology provides some exciting and powerful possibilities. Simple print programs can give students and teachers the opportunity to cooperate in the creation of language-rich environments replete with images. CD-ROM and videodisc resources allow students to explore literature and the world around them in new ways and become producers of multimedia projects.

This session will highlight a variety of practical yet exciting programs that show how technology can support and enhance the whole language classroom. Emphasis will be placed on the development of reading, writing, listening, and speaking skills as well as critical thinking, cooperative learning, and cross-curricular integration. The presenter will demonstrate appropriate software, including a new product still under development, and discuss practical considerations for integrating these technologies into a literature-based classroom.

Inquiry-Based Learning Environment Provided by Database

Jho Ju Tu
University of Southwestern Louisiana
Lafayette, LA

Abstract

Using computers in education has been practiced by all levels of schools for many years. Teachers and educators have long searched for the best strategies of using computers to enhance teaching and learning. One of the key components that speed up the use of computers in education explored by the educators in recent years is database. Many researchers (Budin, 1988; Hunter, 1985; Strickland and Hoffer, 1989; Turner and Land, 1988) have indicated that the inquiry-based learning environment provided by database can be highly suitable for developing higher order thinking and problem-solving skills.

This presentation will use the database provided by AppleWorks on Apple IIGS computers to demonstrate how inquiry skills and problem-solving ability can be improved for students in grades 5-8. The AppleWorks is chosen because of the wide availability of the Apple Computers in local schools. Examples to be discussed in this presentation are experiments of student teaching assignments from a course in computer literacy education offered by the Department of Curriculum and Instruction at the College of Education, University of Southwestern Louisiana. This course is designed to teach methods and materials in computer education. Students in this course are to learn to teach computer literacy and have opportunities to implement their lesson plans in actual classroom settings. Various teaching methods, such as direct instruction, implicit teaching method, and project approaches are introduced to student teachers in this class. It is hoped that examples given in this presentation will be of interest to the attendants of this demonstration and provide school teachers with practical guidelines to employ database as one of the alternatives to teach problem-solving. Theoretical background and practical rationale for integrating database into the curriculum for teacher education will also be presented.

Projects (W1.13)
Restructuring

Restructuring Education in New York State

Peter Flyzik, Richard Steinfeldt, and Harry Tuttle
New York State Association for Computers & Technologies in Education
Canisteo, NY

Abstract

Technology can help transform the curriculum and the classroom so that students become active learners, work on projects in cooperative learning groups, deal with information in many different forms, and produce data, information, and media for others to use in practical and efficient ways. When students use technology as tools for obtaining and demonstrating knowledge, they learn in new ways. This is true restructuring of education in our schools.

Officers of the New York State Association for Computers & Technologies in Education (NYSC&TE) will present several examples from restructuring projects in New York State that utilize technology as a cornerstone and allow students to learn in new ways. Time permitting, examples will include efforts in a single classroom, a department, a school building, and an entire district.

When the Magic Has Faded... What Next?

Jeff Holte, Shirley Kratochuil
St. Louis Park Schools
St. Louis Park, MN

Abstract

After the computers are purchased, the video is in place, the software is installed, and the conferences have been attended...then what happens? How do you move an entire district, including staff and students, to use these new tools in a meaningful manner while meeting the expectations of the community and school board?

Some successful strategies that are used by the St. Louis Park School District in Minnesota include: three day summer technology camps for teachers held at an environmental center, summer technology "playgrounds" for teachers, peer involvement using the district wide video and data networks, ownership via building technology committees and customization of staff offering for individual schools. Approaches and strategies to facilitate integration need to be fluid as the staff has changes in their knowledge and expertise. St. Louis Park Schools will share their successes and failures in the ever evolving process of technology integration implementation.

Choosing Success—Florida's Co-Development Project for Students at Risk (Grades 9-12)

Ann Kinstler
Dade County Public Schools
Miami, FL

Mike Eason
Florida Department of Education
Tallahassee, FL

Cheryl Weiner
Computer Curriculum Corporation
Sunnyvale, CA

Abstract

Choosing Success is a highly innovative multimedia program being developed jointly by The Florida Department of Education, Dade County Public Schools, and Computer Curriculum Corporation. The program will provide a curriculum that addresses the needs of at-risk students in grades 9-12. The goal of the program is to help students learn attitudes, behaviors, and skills that encourage them to stay in school and lead healthy, successful lives.

The program will use state-of-the-art technology and a guided self-discovery approach to learning that focuses on real-world problems and issues relevant to lives of adolescents. The skills and understanding needed for living in a complex society will be taught through thought-provoking scenarios relevant to students. These scenarios will be the springboard for authentic learning activities that teach students how to apply cognitive and affective strategies. Problem solving, decision making, goal-setting, and conflict resolution to real-life situations will be emphasized throughout the program.

The content of the course will cover a wide range of topics related to:

1. Social Expectations and Behavior
2. Health and Personal Habits
3. Employability Skills
4. Life Habits and Carry-Over Skills
5. Literacy, Mathematics, and Higher-Order Thinking Skills.

Professional Development for Tomorrow - Creating Magic through Technology and Restructuring

Sue Misiak, Jane Hoover, Betsy Sidovenko, and Sheila Cantlebary
West High School
Columbus, OH

Abstract

Teachers Sue Misiak and Jane Hoover will describe the Apple Classrooms Of Tomorrow (ACOT) Teacher Development Center in Columbus, Ohio, Summer Institute '92, and the practicums which were conducted to provide professional development for tomorrow's teachers. Handouts and videos will support the presentation.

The first ACOT Summer Institute, a collaborative effort between the Columbus City Schools, the Columbus Education Association (CEA), Apple Computer, Inc., and The Ohio State University, was a program with a clear and focused mission: to expose teachers to a variety of teaching strategies designed to restructure their practice in order to improve student motivation and academic proficiency. This was the first step in a proposed National Science Foundation grant in which twelve high school teachers representing nearly all the academic and non-academic disciplines participated in professional development activities centered around cooperative learning, interdisciplinary lessons, and technology enrichment.

Upon receiving the NSF grant money, the program was expanded to include teams of teachers from other Columbus schools for practicums during the school year, with more training provided during Summer Institute '93.

Spotlight Session (W3.1)

Networking in the Nineties: An EduQuest View

Kathy Murray and Linda Randall
IBM/EduQuest
Atlanta, GA

Abstract

This session will introduce the audience to EduQuest's strategic networking directions for K-12 schools. Discussion will focus on:

- the changing school environment
- consideration in making cabling decisions (Fiber, Token Ring, Ethernet)
- software solutions, including operating systems and common user interfaces
- multimedia networking considerations

Society Sessions (W3.2)

Object Oriented Programming: What High School Teachers Need To Know

International Society for Technology in Education (ISTE)

Chris Stephenson, Panel Chair
University of Toronto
Toronto, Ontario

Abstract

Object oriented programming has become the latest hot topic in software development circles. Arguments abound about its ultimate application, but very few are questioning its relevance as a design paradigm. This panel will provide a teacher-friendly look at OOP from a variety of instructional and programming language perspectives. Some lively debate about OOP's potential classroom relevance should ensue.

Participants:

Allen Brown
Queen's University

Iain Ferguson
Nova High School

Ric Holt
University of Toronto

Harriet Taylor
Louisiana State University

Sharon Yoder
University of Oregon

This abstract was taken from the author's originally submitted proposal

Society Sessions (W3.3)

Building Treehouses for Learning: Thematic Technology Tools For Kids

Association for Educational Communications and Technology

Annette Lamb
University of Toledo
Toledo, OH

Abstract

Much of the fun a treehouse is the preparation that goes into its construction. From choosing the right tree to making the sign for the door, consider the learning that takes place as students construct a treehouse. Math, science, social studies, and communication skills are all essential. Educators invest much of their time building intellectual treehouses for children. An alternative approach provides a wealth of technology tools that students can manipulate for exploration and construction. In other words, a carefully planned multimedia learning environment focusing on a particular theme can stimulate learning without distracting from exploration. Multimedia thematic units are an interdisciplinary approach to learning that combines context-based text, aural, and visual elements into an active learning environment.

This session will provide ideas for developing motivating learning environments that incorporate technology tools. Emphasis will be placed on integrating various technologies and stimulating innovative student projects that stress process-based activities and assessment.

This abstract was taken from the author's originally submitted proposal

Society Sessions (W3.4)

Integration of Technology Into Field Experiences of Preservice Teachers
ISTE / SIGTE

Neal Strudler, Panel Chair
University of Nevada
Las Vegas, NV

Abstract

Teacher education programs prepare preservice teacher to use technology through three main components: specialized educational technology courses, integration of technology into methods courses, and the application of technology in students' field experiences. Of the three areas, the field component is perhaps the most critical and generally, the most neglected. While teacher educators are attempting to expose students to effective uses of technology in their coursework, students are often not given the opportunity to observe and practice effective technology use in the field. This panel discussion will focus on efforts by various colleges of education and school districts to address this critical need. Specific program initiatives as well as implementation issues will be discussed.

Participants:

Barbara Brehm
Eastern Montana College

Doris Carey
University of Colorado, Colorado Springs

Peggy Kelly
California State University, San Marcos

Michael Waugh
University of Illinois

This abstract was taken from the author's originally submitted proposal

Society Sessions (W3.5)

Notebook Computers: Features and Options for Educators

Special Interest Group on Computer Uses in Education

Doris M. Carey and Regan F. Carey
University of Colorado
Colorado Springs,CO

John D. Lawson and Lynne Anderson-Inman
University of Oregon
Eugene, OR

William Baird
Auburn University

Abstract

Notebook computers have been in use for several years. Teachers generally report great enthusiasm from students who utilize these highly portable machines to support their writing and studying efforts. At the same time, teachers have serious concerns about power supplies, security, and equity issues. Schools, school districts, and colleges are attempting to assess the benefits and drawbacks of notebook computers as alternatives to the traditional desktop personal computers found in computer laboratories.

This session will outline the features of notebook computers, with emphasis on features that appear to enhance and/or hinder their use in schools. A variety of suggestions for integrating notebook computers into subjects across the curriculum will be shared, with special attention to the types of software which help make notebook computers viable as personal learning and studying tools. Participants will also have a chance to see video footage of notebook computers in use in elementary, secondary, and college settings across three states. They will receive handouts that outline the costs and features of a variety of notebook computers on the market. Responses from vendors of notebook computers will also be presented during the session.

Paper (W3.6a)
Electronic Mail Simulations: Powerful Training Tools

Mike Eason
Bureau of Educational Technology
Florida Department of Education

Ann E. Barron
Florida Center for Instructional Technology
University of South Florida

Karen Ivers
University of South Florida

Abstract

Computer simulations have been developed by the Florida Center for Instructional Technology at the University of South Florida in Tampa to provide training in electronic mail for educators. This project was funded by the Florida Department of Education, Bureau of Educational Technology, and the Florida Information Resource Network. The training covers an overview of telecommunications with information about hardware configurations and software settings. The program also contains a detailed simulation of FIRNMAIL, the electronic mail system for public educators in Florida. This paper addresses the need for the project, as well as the design, development, and dissemination.

Introduction

With emphasis on real-world and collaborative learning experiences, the potential of telecommunications in education is receiving more and more attention. Telecommunications enables students and teachers to obtain multiple sources of information, services, and electronic mail (Barron & Orwig, 1993). It provides increased motivation for students to write, collaboration opportunities in research, and broader understanding of other cultures (Steinberg, 1992). Through telecommunications, the typical classroom is no longer bound by four walls, but open to include students and learning experiences from around the world. Telecommunications is changing the way students learn, where they learn, and who teaches them (Kurshan, 1990).

Telecommunications in Florida

In order to electronically link all levels of the public educational system in Florida and provide access to telecommunications, the Florida Legislature established the Florida Information Resource Network (FIRN). This wide-area telecommunications network connects data centers and computer resources at universities, community colleges, and school districts (Schmid, 1990). In addition, teachers and administrators can access the network via an electronic mail system, called FIRNMAIL.

Through FIRN and FIRNMAIL, all users have **free** access to a wide variety of computing resources and services. For example, teachers and students can retrieve information from remote databases at the state universities, including the online library catalogs and the Educational Resources Information Center (ERIC). They can also download a weekly teacher's guide to Newsweek or image files of satellite weather. In addition, through FIRNMAIL, educators can send and receive messages to other educators throughout the state and participate in conferences of common interests.

Several technical personnel are located throughout the state to provide inservice training sessions on how to use the electronic mail system. Most of the training sessions take place in local schools. In such settings, it is nearly impossible to provide hands-on training for the participants because few schools have more than one or two telephone access lines.

The need for a vehicle to train educators to use electronic mail led to the development of computer-based simulations. Simulations adapt well to a wide range of learners and allow students to practice skills with a high degree of realism (Gorrell, 1992). The computer simulations were designed to emulate the FIRNMAIL system without requiring telephone connections.

Design of the Simulation

The simulation program was designed and developed by the Florida Center for Instructional Technology at the University of South Florida, one of four centers funded by the Florida Department of Education. The program was designed for educators as well as students in grades six and above.

The topics of the program are divided into four major categories, which became the Main Menu choices. These categories include: (1) Telecommunications Basics, (2) Overview of FIRN, (3) FIRNMAIL Simulation, and (4) Educational Applications. Each category is sub-divided into additional selections. Throughout the program, maximum learner control is provided through permanent menu options and an interactive course map (see Figure 1). Students can choose the selections in any order, repeat them if they wish, and exit at any time.

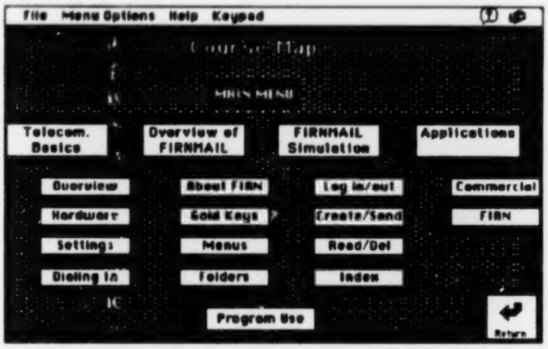
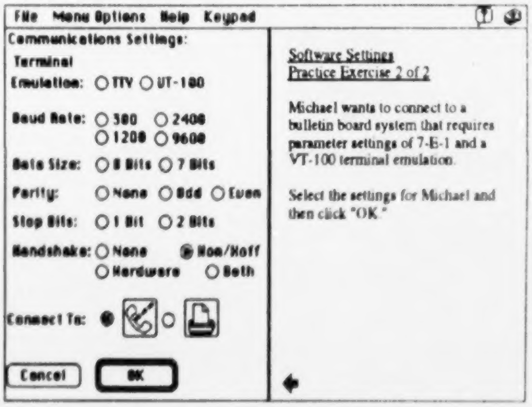

File Menu Options Help Keypad
Course Map
MAIN MENU
Telecom. Basics
Overview of FIRNMAIL
FIRNMAIL Simulation
Applications
Overview
Hardware
Settings
Dialing In
About FIRN
Gold Keys
Menus
Folders
Log in/out
Create/Send
Read/Del
Index
Commercial
FIRN
Program Use
Return

Figure 1. Course Map.

Telecommunications Basics

Using a tutorial format, the *Telecommunications Basics* section of the program provides background information on telecommunications. Through animations and interactivity, the lesson demonstrates the function of a modem, the hardware requirements, and the software settings. Figure 2 is an example of one of several practice exercises that are included to reinforce the concepts presented. The *Telecommunications Basics* section also includes a simulation of the dialing procedure.


File Menu Options Help Keypad
Cancel
OK

Communications Settings:

Terminal

Emulation: ○ TTY ○ VT-100

Baud Rate: ○ 300 ○ 2400 ○ 1200 ○ 9600

Data Size: ○ 8 Bits ○ 7 Bits

Parity: ○ None ○ Odd ○ Even

Stop Bits: ○ 1 Bit ○ 2 Bits

Handshake: ○ None ● Xon/Xoff ○ Hardware ○ Both

Connect To: ● ○

Software Settings
Practice Exercise 2 of 2

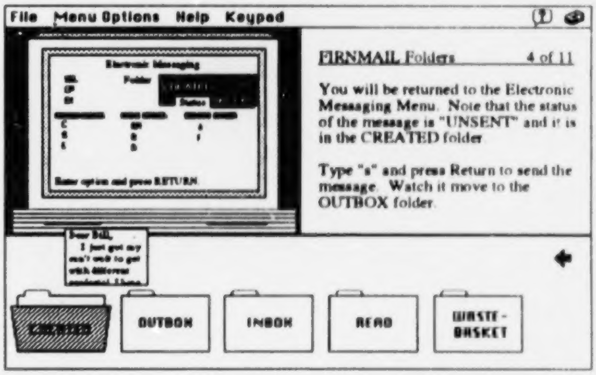
Michael wants to connect to a bulletin board system that requires parameter settings of 7-E-1 and a VT-100 terminal emulation.

Select the settings for Michael and then click "OK."

Figure 2. Practice Exercise for Software Settings.

Overview of FIRN

The second section of the program provides an overview of FIRN and FIRNMAIL. This section illustrates how messages are transferred in electronic mail and incorporates graphics to introduce the concept of electronic folders. A description of each FIRNMAIL folder is provided, followed by a series of screens that provide simulated sequences of message processing. Animations are also included to illustrate the movement of messages from folder to folder (see Figure 3).


File Menu Options Help Keypad
Electronic Messaging
Folder
Status
Enter option and press RETURN
Dear Bill,
I just got my
CREATED
OUTBOX
INBOX
READ
WASTE-BASKET

FIRNMAIL Folders 4 of 11

You will be returned to the Electronic Messaging Menu. Note that the status of the message is "UNSENT" and it is in the CREATED folder.

Type "s" and press Return to send the message. Watch it move to the OUTBOX folder.

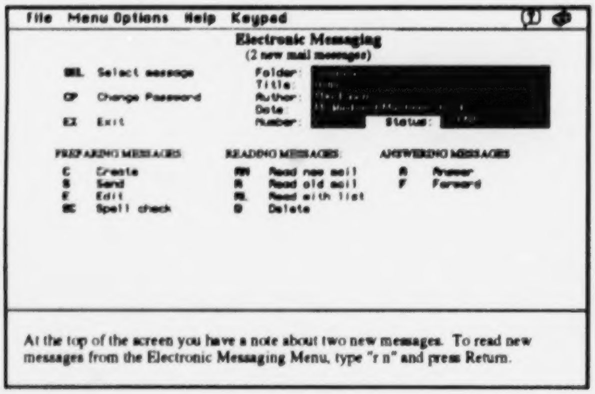
Figure 3. Tutorial Screen for FIRNMAIL Folders.

FIRNMAIL Simulation

The third segment of the program contains a detailed simulation of FIRNMAIL. This section was designed to provide guided practice for the most common functions of FIRNMAIL. Students can emulate the keystrokes and procedures required to create, send, read, index, and delete

BEST COPY AVAILABLE

messages. The screens are actual system screens, captured and incorporated into the simulation (see Figure 4). The keystrokes emulate the system and provide a high degree of transfer to the real system.



At the top of the screen you have a note about two new messages. To read new messages from the Electronic Messaging Menu, type "r n" and press Return.

Figure 4. Simulation Screen for FIRNMAIL.

Educational Applications

The final section of the courseware provides information on educational applications. A listing of the names and focus areas of several commercial applications, such as GTE World Classroom, Prodigy, and America Online, is included. The address and telephone numbers of vendors are also provided for those seeking further information.

Similar information is included for applications that are specific to Florida. For example, Florida educators have access to the online catalog system at the state universities, software lesson plans, and various other databases. An overview of the services is provided and access procedures are included.

Development

To meet the training needs of educators throughout Florida, the courseware was developed for both Macintosh and MS-DOS environments. The same basic design structure was incorporated with variations as required by the authoring tools.

Macintosh

The first development effort focused on the Macintosh environment. HyperCard was chosen as the authoring tool because of its accessibility and ease of use. In order to run this version of the simulation, a Macintosh computer with at least one megabyte of memory and the HyperCard 2.0 program are required.

Because FIRNMAIL incorporates a variety of user options, HyperTalk was used for answer analysis and multiple variable manipulations. Field and card handlers were included to trap responses and branch the user accordingly. Highlighting features were designed to direct the users' attention to defined areas, and tailored corrective feedback was included to help guide the user through the simulation.

The graphics for the system screens were produced by capturing FIRNMAIL screens and transferring them into HyperCard. Additional images were developed using a variety of clip art and original graphic designs. In order to enable delivery on the range of Macintosh computers, the screen size was designed for the Macintosh Classic. Print options were included to provide the user with hard copies of specific information, including local dial-up modem numbers, FIRNMAIL application procedures, and commercial vendors.

MS-DOS

After the program was prototyped in HyperCard, the second development effort was undertaken. TenCORE was chosen for the authoring tool for the MS-DOS environment because it does not require Microsoft Windows and it will run on CGA monitors. In addition, TenCORE includes the complex response handling and branching required for the simulation.

In the MS-DOS version, keyboard alternatives were included for all interactions. The program was designed to run in EGA with 16 colors. To reach the widest possible audience (including CGA monitors), precautions were taken to ensure that the final product would also run on CGA monitors (in monochrome).

Dissemination

The program is being disseminated throughout Florida free-of-charge by FIRN and the Florida Center for Instructional Technology at the University of South Florida. In conjunction with this effort, paper-based training materials were also produced, such as brochures on specific FIRN services, quick reference cards for accessing the services, and a booklet on telecommunications basics. Thousands of the materials have already been distributed and the demand for additional copies is overwhelming.

For further information, or a copy of a simulation, contact:

The Florida Center for Instructional Technology,
College of Education, Room 208B
University of South Florida,
Tampa, Florida, 33620
Phone: (813) 974-3470
FIRNMAIL: BARRONA.
Bitnet: ABARRON@CFRVM
Internet: ABARRON@CFRVM.CFR.USF.EDU

References

Barron, A. E., & Orwig, G. W. (1993). *New Technologies for Education: A Beginner's Guide*. Englewood, CO: Libraries Unlimited.

Gorrell, J. (1992). Outcomes of using computer simulations. *Journal of Research on Computing in Education*. *24*(3), 359-366.

Kurshan, B. (1990). Educational telecommunications connections for the classroom — Part 1. *The Computing Teacher*, *17*(6), 30-35.

Steinberg, E. R. (1992). The potential of computer-based telecommunications for instruction. *Journal of Computer-Based Instruction*. *19*(2), 42-46.

Schmid, B. (1990). FIRN: Florida's statewide educational network. *Florida Educational Computing Quarterly*, *2*(4), 83-89.

Paper (W3.6b)
Computer Networking: A New Tool for Student and Teacher Education

Margaret Riel
Lecturer, SCSd
Encinitas, California

Abstract

Computer networking creates a global audience for classroom work. Students who are involved in intellectual exchanges with students in other locations take pride in their work. This results in student gains in writing skills, and the development of interpersonal skills that will be productive for work in international settings. This presentation (1) describes research results of audience effects on the writing skills of elementary, intermediate and high school students involved in network projects, (2) presents the Learning Circle model for cross-classroom, cross-curricular collaboration, and (3) discusses the use of the Learning Circle model in teacher education.

Audience Effects on Writing Skill

Audience considerations play an important role in the creation of text by experienced writers, but they are often nonexistent in classroom writing. Some researchers have suggested that the lack of audience awareness found in early school writing indexes the slow development of the necessary social-cognitive skills to conceptualize different audiences. It is just as possible that it results from the decontextualized approach to writing that is prevalent in classrooms. The following studies suggest that when students used writing to share their ideas with distant audiences, they showed a marked increase in writing motivation and performance.

Audience Effects on Elementary Students

Elementary school students from California, Alaska and Hawaii were involved in a newswire journalism project using computer communication. Riel (1989) used school administered, standardized achievement tests to examine the effects of the telecommunication project on the language skills of fourth graders in California who participated in this project. At the beginning of this project, the class average was slightly below grade level in language and math. At the end of the year that included the publishing of three class newspapers with articles from partners schools, the class average in the language portion of test indicated a gain of two years while the math scores remained close to grade level expectancies. The strongest findings were for the students who served as editors for the first edition of the class newspaper. This group scored 2 to 3 grades above their current grade in the language mechanics subtest, or a gain of four years. The teacher in this classroom did all instruction in grammar through peer editing groups.

These findings suggest that writing and editing for publication is a more effective way of learning language mechanics than the more standard grammar drills. While it is difficult to match classrooms as controls, student work and scores in another class that created a local paper without the network link to Alaskan classrooms were evaluated. The scores of these students showed slight increases over the expected one year gain, but the gains were not significant. This suggests that the distant audience played an important role in student motivation and learning.

Audience Effect on Intermediate Students

Cohen and Riel (1989) examined the quality of students' writing in two audience conditions: to their teacher for a term assessment; and to a distant peer audience to share ideas. Seventh grade students wrote two compositions on the same topic, one addressed to peers in other countries via a computer network and the other to their teacher for their semester grade. The essays were written one week apart. In a second classroom, students followed the same procedure but in reverse order. The papers from both sessions were collected, the title pages removed and graded by the teacher. In both classrooms, there were significantly higher ratings of the papers written to communicate with peers than those written to demonstrate skill in writing. Analytic scoring of the papers indicated that the essays written for a distant audience were more fluent, better organized and ideas were more clearly stated and supported than those written for a grade.

The difference in the quality of essays indicated that students were better able to demonstrate their skill in writing when communication, rather than evaluation, was their goal. Organizing school writing around communication with distant audiences can help students acquire a sense of what information is required by the reader. Communication with people at a distance also exposed students to a range of strategies for conveying information in a clear format.

Audience Effects on High School Students

Spaulding and Lake (1991) suggest that benefits of computer networking may be greatest for the students who traditionally do not perform well in regular classrooms. Their research involved 28 first-year high school students who did not pass district-level competencies in writing. These students were assigned to classes that were similar with the exception of participation in networking activities. In one class, the students were part of a Learning Circle on the AT&T Learning Network. They interacted with students from 6 classes located in three countries. They worked on classroom projects sponsored by each of the classrooms. Their collective work was published cooperatively in a booklet. The second class did similar projects but used encyclopedias and resource books to gather the information. They served as a control group. Student work was also formed into a booklet. The teachers used the same "writing process" approach to teach writing in both conditions.

The independent variables, linguistic self-efficacy and computer self-efficacy, were assessed with a pencil and paper self-report instrument. The dependent variables were holistic scores on pre- and post-test essays and course evaluations. The most significant finding was the relationship between students low on the linguistic self-efficacy instrument and their essay scores in the two conditions. Students with low linguistic self-efficacy scores who participated in Learning Circles showed the most dramatic gains in the study. Students who rated themselves low in writing skill and who participated in control class did not show significant improvement. For some students the second essay was rated lower than the first. They concluded that collaborative learning with peers over a computer network can be an effective teaching tool for students who have not been successful in traditional learning environments.

Summary

These studies indicate that electronic networking can serve as a successful educational tool within the writing curriculum. Its effectiveness may, as Spaulding and Lake suggest, be strongest for groups of students who, because of a lack of interest in traditional practice activities in classrooms, have a low confidence in their skill. The use of intrinsic motivation that is provided in a real communication exchange may be a very productive way of increasing interest and competence.

Cross-Classroom Collaboration in Learning Circles

Experimentation with classroom use of electronic networks indicated that writing was only one of the many ways that cross-classroom exchanges could enhance classrooms instruction (Levin, Riel, Miyake, & Cohen 1987). What was needed was a cross-classroom group strategy for integrating electronic communication with important curricular goals.

This strategy is called Learning Circles and has recently been implemented on a large scale by the AT&T Learning Network. Learning Circle encourage a cross-classroom team approach to learning. They are organized around the concept of an electronic school rather than the open conferencing model that characterizes many educational networks (Riel 1989). Instead of linking classes to all other classes on the service, each class becomes a member of a small group that makes up the Learning Circle. Learning Circles are defined by one of seven curriculum themes. Some Learning Circles are also offered in French, Spanish and German as well as in English. The grade level range (elementary, middle and high) of a Circle is also specified.

Network Design

Sustained interaction over time is the first marker of success in the construction of an electronic community. Continued regular interaction is an implicit validation of the usefulness of the dialog for the participants. Participant structures (Philips 1982) were compared among successful and unsuccessful network communities of university researchers, of school teachers, and of elementary students (Riel & Levin, 1990). The participant structure analysis of networks resulted in the following three recommendation for the design of electronic networks:

a. The less prior knowledge among the participants, the more important it is to have a strong commitment to a well-defined, group task.
b. Access to the network should be convenient and reliable for all group members or there should be high motivation for using the system (low cost, job requirement, or course assignment).
c. Network communities need some form of leadership to monitor and facilitate group interaction.

The design of Learning Circles incorporates these recommendations in the following ways:

- Prior Work Relationships and Group Task. Since participants are matched into new Learning Circles each session, the common task provides group cohesion. The curriculum guides outlines the group task and establishes a common time frame. Each school contributes one project to the group task which increases a sense of group ownership. Each Learning Circle cooperatively produces a publication presenting their collective work. The well defined group task structure is balanced with the flexibility of teacher and student choice of projects.
- Ease of Access and Response Obligation. Participation on the Learning Network is a choice made by the teachers and students, therefore it was important that the design of the technical system automate the exchange of mail making the technical aspects subservient to the educational aspects. Team spirit is fostered among the small groups of classes who belong to a Learning Circle. A timeline, the

interdependence of the Circle members, and regular messages from the Learning Circle team, creates a sense of obligation of each class to interact regularly.

3. Coordination and Assessment. Successful networks all had someone who monitored and coordinated the interaction. On the Learning Network each Learning Circle has a Circle Coordinator to help facilitate the interaction and is part of a larger unit of about six Learning Circles monitored by a Mentor Coordinator. Mentor Coordinators serve as resources for curricular ideas and monitor the progress of the Learning Circles.

A Learning Circle encourages teacher and student creativity within a structured framework. The group works as a team to complete projects drawn from each other's classroom work and to share their results in a written summary.

Phases of a Learning Circle

Teachers and students in Learning Circles work cooperatively to design and carry out projects that extend curricular activities in their classrooms. Like any classroom activity, classroom telecomputing needs careful planning and structure. In Learning Circles, teachers and students share a set of educational goals and work along a specific timeline with fixed beginning and ending dates. Learning Circle interaction is structured by phases with goals and tasks allowing for cooperative planning among the participants. The six phases guide the interaction:

1. *Getting Ready:* The first phase involves reading materials and learning how to use the communications software. The design of the software takes into account the constraints of the classroom setting by automating the exchange with the host computer. A tutorial training disk and access to 24 hour assistance by phone is sufficient technical training for most users to be comfortable with the communication process.
2. *Opening the Circle:* The first Circle message welcomes participants to their Learning Circle. Introductory activities that include a classroom survey with questions about the students, their school, and their communities. In longer Learning Circles, the students exchange pictures and other materials through postal mail. The introductory activities are organized by the Learning Circle Team.
3. *Planning Circle Projects:* Each class in a Learning Circle is invited to sponsor a Learning Circle project centered around their classroom curriculum. Sponsoring a project requires planning, requesting, collecting and analyzing information from other students, on a topic or issue chosen to fit with the classroom curriculum.
4. *Exchanging Student Work:* Sponsored projects are described and students begin to send their work on each of the sponsored projects. Students become reporters, authors, poets, or researchers responding to the requests of other schools. Often the class is divided into small groups and each group is responsible for responding to one of the projects. During this time students need to direct the work of students on their projects and respond to the requests from their partners.
5. *Organizing Circle Publication:* Communication across distances on electronic networks is the vehicle, not the goal, of the activity. In order for the often exciting exchanges to make a lasting impression, students need to spend time reviewing and evaluating the learning experience. Creating a Circle publication helps students reflect on what they have accomplished and organize their work in a presentation to others. The choices they make about what to include and how to organize the information helps them learn important information handling skills that are of increasing value in the workforce.
6. *Closing the Circle:* In this final week of the Circle, students exchange print copies of project summaries and assemble them to create their Circle publication. The clear presentation of their work to others at a distance is another skill that students learn through their participation in the Learning Circle. The Circle ends as students thank and say goodbye to their online teams.

The project approach to exploring and solving real problems characterize Learning Circle activities. The Learning Circle projects encourage the integration of different subjects placing knowledge and skill in the context of their use in the adult community. Here are some examples of projects sponsored by schools in Learning Circles:

- Elementary students in Saudi Arabia sponsored a project on solutions to the Gulf crises. Together with their partners in different countries they discussed the world dependence on oil, kingdoms, democracies, and conflicts between political and religious beliefs.
- Community comparison projects challenged unexamined assumptions students held about the world. For example, students learned that in the desert terrain of Coober Pedy, Australia, people build their homes underground to escape the heat of the sun; in Alaska after the fall setting of the sun, schooling takes place in the dark of night, in California skateboards transport students to school while snow shoes and skis are more commonly used by the Canadian students.
- A school in West Germany located in a farming district sponsored a project on the plight of small farmers. They found that students who lived on small farms in Illinois were facing many of the same extreme conditions that existed in Germany.
- High school students designed studies of the homeless, illiteracy, or substance abuse, or explored differences in family patterns or causes of suicide across cultures. These surveys and interviews helped students to appreciate the complexity of societal and global problems.

Qualitative analysis of the Learning Circles suggests that it is an effective strategy not only for student achievement, but for teacher development (Riel 1990; 1992). Teachers cite the development of new teaching strategies and their professional development as the most important reason for their continual participation on the network.

Learning Circles in Teacher Education

Electronic networks are used in a range of ways at the university level. Many students use data bases to provide them access to the most current information on topics they investigate. Students often use bitnet and internet accounts to communicate with students and educators throughout the world. Some students are enrolled in courses that are delivered in part or in whole through computer conferences systems (Harasim, 1990). This form of instruction makes it possible for students who are geographically isolated to take part in a wide range of courses.

But at present, there are very few programs that give students the same type of experiences that Learning Circles provide for younger students—the experience of working within a geographically diverse research team sharing information that is locally available.

AT&T is currently experimenting with the Learning Circle concept at the college and university level. Student-teachers, in teacher educational programs, are being given the opportunity to collaborate with their distant peers on issues of classroom design and instructional strategies. Teacher educators help their class work as teams to sponsor classroom activities. One or more student teachers in each of the partner classes try the lesson or activity in a local classroom and sends back their evaluation of the lesson. The sponsoring class uses the experiences of teachers in many different locations with vastly differing student populations to evaluate the teaching technique. Each class publishes a report summarizing their teaching idea and the ideas, suggestions and experiences of the student-teachers from experimentation. All of the reports together form the Circle Publication for this Learning Circle.

This exchange of ideas among teacher educational programs helps in the diffusion of locally constructed ideas. It also provides for the development of a network of peers throughout the world who can continue to provide resources and ideas as they develop teaching skills. The student-teachers will be able to build on their experience of working on networks to help design projects for their students. As was the case with computer use, when teachers begin to use telecommunications to enhance their learning, they will develop flexible and creative ways to integrate telecomputing into the learning sequences of their students.

References

Cohen, M., & Riel, M., 1989. The effect of distant audiences on students' writing. *American Educational Research Journal*, 26, 143-159.

Harasim, L. 1990. *Online Education*. New York: Praeger.

Levin, J., Riel, M., Miyake, N., & Cohen, M. 1987. Education on the electronic frontier: Teleapprentices in globally distributed educational contexts. *Contemporary Educational Psychology*, 12, 254-260.

Philips, S. 1982. The Invisible Culture. New York: Longmans.Riel, M. 1989. The impact of Computers in Classrooms. *Journal of Research on Computers in Education*, 22: 180-190.

Riel, M. 1990. Cooperative learning across classrooms in electronic learning circles. *Instructional Science*, 19, 445-466.

Riel M. 1992. Learning Circles: A functional analysis of educational telecomputing. *Interactive Learning Environments*, 2, 15-30.

Riel, M., & Levin, J. A. 1990. Building electronic communities: Successes and failures in computer networking. *Instructional Science*, 19, 145-169.

Spaulding, C. & Lake, D., 1991. Interactive effects of computer network and student characteristics on students' writing and collaborating. Paper presented at the Annual Meeting of the American Educational Research Association, Chicago, April 3-7.

Paper (W3.6c)
Mediation in Network-based Learning Activities: Successful Technical and Content Strategies

Clinton E. Stapleton
Clinton Stapleton Consulting
Charlotte Amalie, Virgin Islands

Abstract

This paper presents an analysis of problems encountered by participants involved in integrating network-based learning activities into formal and informal learning contexts. Network learning activities were created by educators and students and supported by a long distance electronic network. The paper also reports solutions developed by activity participants to address network-based lessons and their classroom integration problems.

These approaches are rooted in a pattern of specialized and repetitive tasks carried out by technical and content mediators who may be human or electronic. These mediators make important contributions to the successful integration of network learning activities in instructional settings. Recommendations are made for promoting technical and content mediation for successfully integrating network activities into informal and formal learning contexts.

The sharing of electronic mail, files, and resources by teachers and students over computer networks has great potential for restructuring learning. Communicating and accessing data over an electronic network is a powerful application of computers. Networks allow for new models of education that exploit the strengths of information and communication technology.

Educational applications of a network can prepare and promote meaningful lifelong learning for students and teachers beyond the limitations of classrooms, their resources and traditional concept of schools. However, we still know little about how to successfully integrate network-based instructional activities into learning contexts.

Purpose

This study was conducted to determine the factors leading to the success of educational activities conducted on distributed electronic networks created and implemented by teachers and students.

Method

Educational activities conducted on a nationally and internationally linked network used by thousands of teachers and students were selected as successful then critically analyzed to address research questions. Several methods were used to select successful network activities and to collect and analyze data on those activities.

Sample

Nine hundred and twenty two activity proposals posted on an electronic bulletin board on a grassroots school-based electronic network between January 1989 and June 1990 were examined. Forty-three were selected by using researcher designed criteria and participant self-evaluations. Sixteen of those activities were judged as successful by editors of a mediated electronic bulletin board on the network designed for publishing electronic reports of successful network activities and these were selected for intensive study.

Data Collection

The data for this study consisted of electronic mail messages exchanged on the network as well as diaries of network usage and telephone interviews with key participants of the sixteen successful activities.

Data Analysis

Each network activity was described along several dimensions including organization of the activity, implementation of the activity, problems of the activity, recommendations for improving the activity, and sequence of network stages. Network messages were classified into the following network stages: (a) proposal, (b) refinement, (c) organization, (d) pursuit, (e) wrap-up, and (f) publication. The frequency of messages exchanged for each network stage was tabulated and the sequence of network stages was graphed for activities.

Results/Discussion

An analysis of the sixteen successful network activity ideas demonstrated that developing and shaping content and overcoming technical barriers were major component of successful network-based activities.

Content Mediation

Contents of Successful Projects

The main purpose of the successful network activities examined was to use the network to collect real data from students, teachers and other collaborators. Shared data, the electronic network, and activities were used as resources, tools, and media for problem solving, motivation, and promoting hands-on learning. Some examples of real data included: (a) soil samples, (b) water samples (c) measurements of the sun's shadow at local noon time, (d) grocery prices, (e) jokes, (f) student's descriptive writings and drawings (descriptions and drawings of nightmares, life in the year 2100, outrageous animals, content's of a magician's box, and contents of a time capsule), (g) student's ratings of the places where they live, (h) student's description of the location where they live, (i) network user autobiographies, (j) survey on America's problems, (k) survey on teenagers, (l) vocabulary words and scrambled and unscrambled list of the United States and their capital cities, (m) descriptions of school lunches, and (n) encrypted electronic messages. Content area experts developed and shaped the activity ideas and provided critical background information. Content data and network collected data were used to promote meaningful interaction and discussion in the classroom.

Origin and Formulation of Successful Ideas

Successful project ideas were created by students, teachers, district curriculum specialists, a network director, and college faculty. Successful project ideas were formulated and developed individually and by collaborating by telephone, electronic networks, face-to-face and in writing with teachers, students, and colleagues to shape and adapt the project idea for the network and the social organization of the network audience.

A number of participants played the role of content experts for successful activities. In the Lunch project a nutrition expert contributed information on the nutritional analysis of school lunches described by participating schools. Students were the content experts at various occasions during the Nightmare Exchange project and the Weather Holidays projects. They shared their personal experiences about nightmares/dreams and the California earthquake.

Technical Mediation

Research supports the notion that teachers and students have successfully conducted meaningful network-based classroom activities (Levin, 1989, Waugh, 1989). However most teachers involved in these activities still contend that an electronic network is a difficult tool to master and integrate into classroom learning activities (Kim-Chung, 1991, Stapleton, 1991). Barriers to successful networking include the lack of time and expertise needed to carry out such activities. Time and expertise are needed to get a local network connection started, master network applications, and design and implement network-based learning activities.

Basic Network Knowledge and Skills

Users must possess basic computer networking knowledge and skills in order to successfully use an electronic network. If this is not possible they must have access to a person who has those networking knowledge and skills.

Getting Started

Before a teacher can participate in a network activity there are a series of tasks that must be carried out. One-time and occasional technical network tasks carried out by network users include creating: (a) a password, (b) a user name/address (c) background information, and (d) conferences, (groups/ mailing lists). Participants of the activities examined successfully carried out the tasks A, B, and C above individually but required assistance from system operators, computer experts and other technicians to accomplish D.

Network Applications

There are several applications of networks that are repeated many times while participating in a network activity (Stapleton 1991). These are typically technical tasks and include: (a) logging on (connecting) to the network, (b) scanning personal and bulletin board electronic mail messages, (c) reading personal and bulletin board electronic mail messages, (d) replying to personal and bulletin board electronic mail messages, (e) forwarding personal and bulletin board electronic mail messages, (f) sending personal and bulletin board electronic mail messages, (g) deleting personal electronic mail messages, (h downloading (copying) personal and bulletin board electronic mail messages, (i) printing personal and bulletin board electronic mail messages, (j) exiting personal and bulletin board electronic mail, (k) logging off (exiting or disconnecting from) the network.

Below is a message sent on the network that illustrates how mediators were able to assist non-technical participants in successfully participating in network projects.

To: [Host-Teacher]
From: [Mediator #1]
Sent: 11/16/89 10:30 am
Subj: response

I am writing for a teacher in one of my schools. We are presently having modem or phone line problems there and she is unable to communicate herself. Her name is [Teacher] and she works with gifted 6th, 7th and 8th graders at our [Middle School] in [City] N.C. Her 8th graders have already been concerned about the lunch program in their school and would like to participate in your project. She can be reached through [TEACHER@NODE]%NCAROLINA. [Teacher] SYSOP, County Schools.

Name of task	Number of Steps
Direct Network Access	3
Remote Network Access	3
Creating a User Account	15
Logging off of Network	2
Logging on to Network	2
Accessing Personal Electronic Mail	1
Accessing Electronic Bulletin Boards	3
Searching Personal Electronic Mail Messages	2
Searching Bulletin Board Messages	2
Reading Personal E-Mail Messages	4
Reading Bulletin Board Messages	4
Replying to Personal E-Mail Messages	6
Replying to Bulletin Board Messages	6
Composing/Sending Personal E-Mail Messages	6
Composing/Posting Bulletin Board Messages	6
Exiting Personal E-Mail	1
Exiting a Bulletin Board	1

Table 1. Approximate Number of Steps Required by FrEdMail Users to Complete Network Tasks

Conclusions and Recommendations

Results of this study suggest that successful network activities have two common elements: participants who know network technology (computer resource staff, computer experts); and participants who know content (teachers). These findings can be used to promote successful projects by making certain that participants of network activities have the content expertise and technical skills needed for network-based activities. An alternate approach would be for teachers to collaborate with computer literate students, local experts, and colleagues who can contribute by offering technical and content skills that are needed for a particular network activity. These experts can range from students and fellow teachers to doctors and research scientists.

Software tools that automate repetitive tasks involved in learning activities should be utilized by those who lack technical skills or time to master network applications. By sharing the responsibility of solving technical and content issues between teachers, students, experts and software, such a dynamic team of mediators can play critical roles in improving the access to and quality of network-based learning activities.

References

Levin, J. (1990, April). *Teleapprenticeships on globally distributed electronic networks.* Paper presented at the Annual Meeting of the American Educational Research Association, Boston, MA.

Levin, J. A., Rogers, A., Waugh, M., & Smith, K. (1989). Observations on electronic networks: Appropriate activities for learning. *The Computing Teacher. 16* 17-21.

Newman, D., & Tors, F. (1990, April). *The world in the classroom: Interacting with data from outside the school.* Paper presented at the Annual Meeting of the American Educational Research Association, Boston, MA.

Riel, M. (1990, April). *Learning circles: A model for educational telecomputing. The AT & T Learning Network.* Paper presented at the Annual Meeting of the American Educational Research Association, Boston, MA.

Stapleton, C. (1991). Analysis of Successful Educational Activities on a Distributed Electronic Network. Ph.D. dissertation, University of Illinois at Urbana-Champaign.

Stapleton, C. E. (1992, April). *Assessing successful educational activities on globally distributed electronic networks.* Presented at the Annual Meeting of the American Educational Research Association, San Francisco, CA.

Waugh, M., & Levin, L. A. (1989). Telescience activities: Educational uses of electronic networks. *Journal of Computers in Mathematics and Science Teaching, 8,* 29-33.

Acknowledgements

I would like to thank educators and students who participated in the network projects examined in this study without whom this sharing of knowledge and techniques would not be possible.

Paper (W3.7a)
RHINO: Creating Learning Experiences, an Overview

Miriam J. Salman Masullo
T.J. Watson Research Center
Yorktown Heights, NY

Abstract

This report is an overview of a larger body of work involving RHINO, a Curriculum Model and its corresponding computer-based prototype and support system (Masullo, 92). This paper introduces the RHINO prototype. The following services are provided by the prototype, and are described as they were implemented.

1. *It serves as a display tool, captures the organization of the model, and allows it to be used for curriculum planning.*
2. *It facilitates the management of learning and teaching objectives via construction of selective subsets of the model.*
3. *It provides tools with which to build a resource base of learning experiences as derivatives of the curriculum model.*

The focus of this report is the presentation of the prototype, and the concepts upon which it is based.

Introduction

RHINO is a curriculum support system based on a curriculum model designed by teachers in the McFarland, Wisconsin school district. It is composed of a version of that model and an implementation of a computer-based prototype of RHINO thus presented here attempts to capture the pedagogical and organizational approaches suggested by the McFarland teachers, thereby facilitating its implementation in the school setting.

The approach taken with this model is to focus on the personal growth of the students by providing broad cross-disciplinary learning experiences that offer a wide variety of learning possibilities. These learning experiences are appropriate to many students all advancing at their own pace.

The intellectual content of the curriculum is organized in an hierarchical fashion. The concepts move gradually from very broad and high level to very detailed and specific; even leading to suggested tools and literary references. The learning experiences are selectively created as subsets of the intellectual content and provide the structural framework for the learning experiences. By virtue of this approach and organization, it is possible to build learning experiences in such a way that their intellectual content is appropriate at some level of understanding to every individual student.

Learning and teaching opportunities are vast and open-ended; but the task of implementing these opportunities becomes quite complex. The computer-based representation of the overall scheme, as presented here, greatly facilitates implementation of the model. The system has as its main goal to make it possible for both students and educators to construct learning experiences in a very natural and intuitive way, within the given sound intellectual content that is being provided as a part of the model.

Background

The intellectual content for RHINO is *Science for All Americans* (SFAA), (Rutherford & Ahlgren, 84). The fundamental question answered by SFAA is the following: What should high school graduates understand about science, mathematics and technology? SFAA answers this question by explicitly defining a view of universal scientific literacy.

The American Association for the Advancement of Science (AAAS) has undertaken a major national initiative to transform science, mathematics and technology education based on SFAA. *Project 2061: Education for a Changing Future* (AAAS, 90) is the result of this initiative and it is unfolding in three stages. The completion of Phase I was marked by the publication of SFAA. During Phase II these high intellectual goals for universal scientific literacy were transformed into alternative curriculum models by teachers from across the nation.

In McFarland, Wisconsin a team of 25 members consisting of five elementary school teachers, five middle school teachers, ten high school teachers, three principals (elementary, middle and high school), and two curriculum specialists worked to design one of these models. This particular model compliments the intellectual content with the philosophy that knowledge is best attained and enriched with human activities that are inherently meaningful to the individual. The high personal goals that it sets challenge both students and educators to make responsible choices, to design possible solutions to real problems, and to reach their potential.

RHINO and its computer-based prototype represent an early attempt to capture and accumulate knowledge about learning and teaching resources. One of the goals for Phase III of Project 2061 is the creation of a resource base of curricula that can serve as a national platform, fittingly supported with technology, for learning and teaching the foundations of science. The RHINO prototype was designed as a tool for exploring issues concerning the technical requirements for such a project. It will be used to help organize the information contained in the learning experiences, so that it can be mapped to an overall approach for ultimately organizing the curriculum resource system alluded to by Project 2061.

Profile of the Model

In this section the conceptual organization of the model is outlined. The more salient aspects of this model, those that relate to its philosophy and pedagogy are not the subject considered in this very limited profile. Only those issues that affected the computer-based prototype, with respect to the way in which the information was organized and its intended use, are discussed. Admittedly, however, the philosophy and pedagogical approach had an impact on the design decisions that were made in mapping to a computer representation.

It is also important to understand that no available database system or Computer Managed Instruction (CMI) system would have been entirely suitable for this application. The computer tool was patterned after the model, and given its characteristics, any such system (database or CMI) would have had to be appropriately adapted. The focus was thus on the required functionality rather than on any particular implementation. Once the suitability of the application approach is established, alternative implementation can be considered.

Organizing Concepts

The RHINO curriculum model organizes the SFAA intellectual content around concepts that are of continuing human concern. One such concept is **food**.

General Content Statements

Each of the organizing concepts is associated with a set of *General Content Statements*. For example, the following are some General Content Statements under food.

- Some methods of gardening are more environmentally sound than others.
- Methods of gathering food, gardening, and farming vary throughout the world and have changed over time.
- Energy from food is necessary to sustain life.
- Living organisms impact the environment.
- Cycles within the physical environment contribute to climatic conditions.

The General Content Statements are intended to be big ideas accessible at some level of understanding to a learner of any experience. The number of General Content Statements per Organizing Concept varies.

Benchmarks

Benchmarks for each General Content Statement signal progression of understanding of the concepts. For example, for the General Content Statement, **cycles within the physical environment contribute to climatic conditions**, the following are some Benchmarks.

- Long term climatic changes are partly due to changes of motion or conditions within the solar system.
- The development of conceptual of physical models is essential to predict cyclic changes.
- People's actions, as well as natural processes, produce long term climatic changes.

Indicators

Indicators then link the General Content Statement and each of its Benchmarks to ways in which to explore the concept at that level of complexity. For example, for the Benchmarks cited, the following are associated Indicators.

- Long term climatic changes are partly due to changes of motion or conditions within the solar system.
  Trace to the present time a variable which has affected climatic conditions and project its effect in the future.
- The development of the conceptual or physical models is essential to predict cyclic changes.
  Use computer programs and/or data from meteorologists to predict climatic conditions for the future.
- People's actions, as well as natural processes, produce long term climatic changes.
  Compare or contrast natural processes, produce long term climatic changes.
  Compare or contrast natural events versus people's activities and their effect on climatic changes or patterns.

Information Sets

In relating this organizational scheme to a computer-based approach, it is useful to group the kinds of information associated with each of the Organizing Concepts into sets. The General Content Statements, Benchmarks and Indicators, together constitute one kind of information set in RHINO, the **conceptual intellectual content**. Other kinds of information sets can be isolate, and potentially many are possible.

Of particular significance in RHINO is the set of **Resources**. This set is typically composed of things like videos, printed material, community resources, etc. Resources associate the conceptual with the factual in a very direct but also subtle way. The model presents a natural mechanism for discretely identifying those facts and activities the seem to correspond to the conceptual learning experiences. It might include that set as a list of suggested **activities** to add to the experience. The following representation is a visualization of that structure.

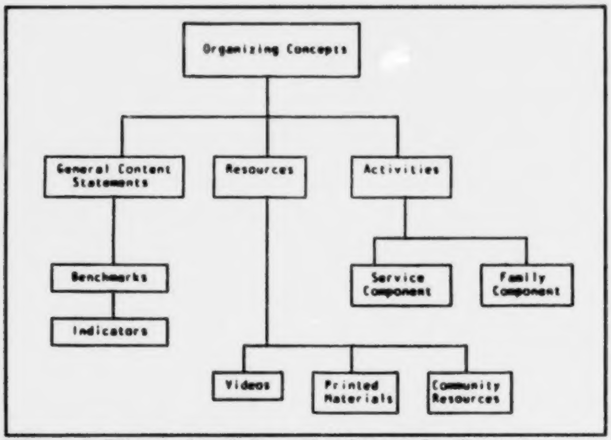

Organizing Concepts
General Content Statements
Resources
Activities
Benchmarks
Indicators
Service Component
Family Component
Videos
Printed Materials
Community Resources

Figure 1. Hierarchical Organization of the Content

Selection or construction of learning experiences, based on this model, is intended to be done by the student with the collaboration of educators, and, whenever possible, the parents of the student.

The RHINO Prototype

The challenge was to formulate a tool to correctly map to both the way in which information is organized in this model and to the way in which that information is intended to be used. There were other added constraints that relate to usability, since this tool will be put, to some degree, in the hands of students. Therefore, it was important to provide ease of use, and immediate and intuitive understanding of the task at hand, that of creating subsets of the given intellectual content, while at the same facilitating management of that content.

It was also a goal to hide all of the mechanics of the system, surfacing to the user only the curriculum model as described in previous sections. The goal was to see and sense only what was described earlier, and to directly perceive the mechanism for its use.

Environment and Design Characteristics

The operations environment for RHINO is the IBM PS/2, under Operating System/2 (IBM, 88). The user interface facility is the Presentation Manager (IBM, 91). The user thus interfaces with a set of screens that are navigated by means of the mouse. There is no data to enter, no queries, no search arguments. The users view the RHINO curriculum model in the same fashion in which it was originally designed.

Because the information was so carefully organized by the teachers in a well structured hierarchical fashion the model lent itself easily to a hierarchical class structure organization of the data. Because the processes that are involved in the manipulation of the information were also so well planned by the McFarland teachers, it was possible to build those into the manner in which the data is presented. The application here captures a global view of the information and the relationships among various information sets, thus allowing structured viewing and selection.

How the Model is Displayed

The model is displayed in tree structure in a left to right fashion, consistent with the way in which it will be read, with the root as its leftmost node. The root node is RHINO, when the entire model is displayed. This node is connected to the Organizing Concepts.

Those nodes respectively connect to the General Content Statements, Benchmarks and Indicators. The following diagram closely resembles what the users would initially see and begin to explore.

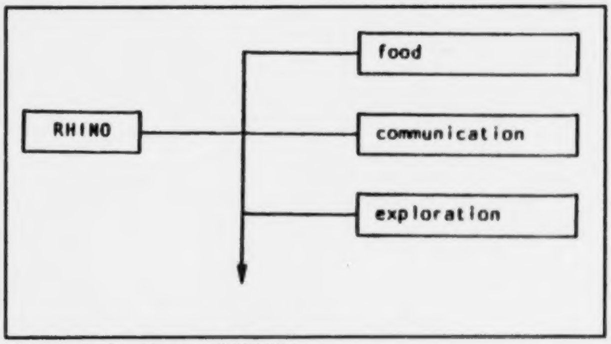

RHINO
food
communication
exploration

Figure 2. Exploring RHINO

Exploring the Model

The model can be explored by selecting (using the mouse) one of the nodes. This effectively navigated the tree from left to right, displaying more of the model. For example, opening the node on food (exploring food), reveals the sub-tree of General Content Statements that follows. Then opening the node on cycles within the physical environment contribute to climatic conditions (exploring its content), reveals the next sub-tree.

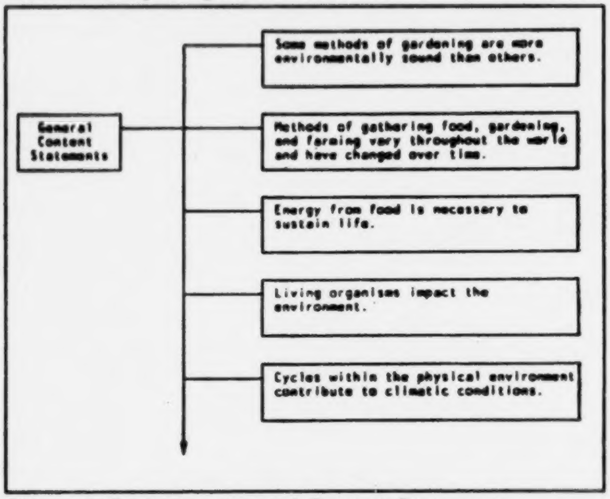

General Content Statements
Some methods of gardening are more environmentally sound than others.
Methods of gathering food, gardening, and farming vary throughout the world and have changed over time.
Energy from food is necessary to sustain life.
Living organisms impact the environment.
Cycles within the physical environment contribute to climatic conditions.

Figure 3. Exploring General Content Statements

The process is iterative and can be reversed, backtracking towards the root (leftmost) node of the model. There is also up and down movement depending on the length of the sub-tree

BEST COPY AVAILABLE

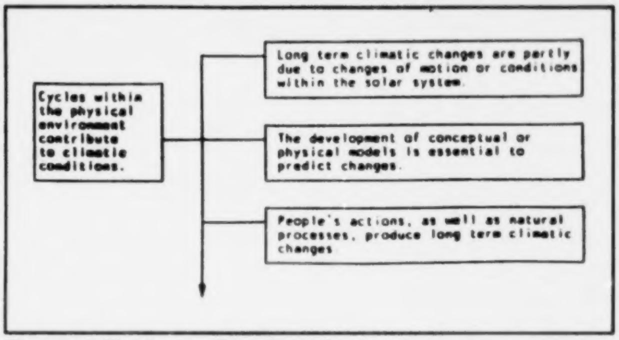

Cycles within the physical environment contribute to climatic conditions.
Long term climatic changes are partly due to changes of motion or conditions within the solar system.
The development of conceptual or physical models is essential to predict changes.
People's actions, as well as natural processes, produce long term climatic changes

Figure 4. Exploring Benchmarks

being displayed. Basically the representation is analogous to the viewing of a large poster that depicts a picture of the content, but focusing on just one portion of the picture at a time.

The display can be toggled back and forth revealing only a given sub-tree, as described above, or the entire hierarchy. Since the size of the display media limits the amount that can be viewed at a time, movement along the four coordinates is available.

Creating Learning Experiences

The processes of creating learning experiences is simple and based only on a highlighting feature. The nodes initially all have a yellow background. Highlighting a node with a click of the mouse results in making its background green. By highlighting nodes a selection is made of those nodes that are pertinent to the learning experience that is being created.

The selection of the concepts and other components, which constitutes the formulation of the learning experience, is determined by the educator. The system as currently implemented does not make those determinations, but it facilitates them.

Once all the relevant nodes are selected, the entire subset is stored as a document and can then be annotated, printed and archived. The criteria under which a learning experience is cataloged is subject to the way in which it will subsequently be referenced, or related to new situations and/or new students. Alternatively teachers and students may choose to search for learning experiences that were carried out by other students.

Updates to the Model

While the model is presently up-to-date, it expected to be the subject of updates by educators, in some locally agreed upon fashion. In particular, the resources component will naturally be updated with new tools and literary references from time to time. Therefore subsets can only be current with respect to the state of the model at the time that they are created.

The learning experiences may become obsolete as new ones are created that are more up-to-date with respect to the new state of the model. Conceptually, both the model and the learning experiences are of lasting educational value. Knowledge about obsolete or out-dated learning experiences is valuable in terms of assessing what works, what has ceased to work, and what did not work. The power of this prototype thus partly lies in the fact that it can generate many models, for many students and many learning situations.

Research in Progress

In this section those issues that refer only to the technology being applied to implement the model will be addressed.

This report explored issues relating to the organization and usability of the prototype, as a vehicle to help implement the McFarland Model in the school setting. A vast amount of information makes up the content of this model, and a vast number of possibilities are made available to the student and the educator when using this tool. This research is the first step in sorting out and understanding the elements of management within the complex set of opportunities that emerge; therefore, changes or modification to the philosophy of the model relating to the manner in which it is used, will be looked at very carefully.

In the research agenda for follow-up work concerning RHINO, priority will be given to studying the criteria by which learning experiences are created, archived, and used relating to the problem of managing instructional goals. A mechanism is being studied for selecting learning experiences by matching them with the needs and interests of the students.

A mechanism for relating instructional materials in the form of multimedia documents, to instructional goals, as extensions of constructing learning experiences, is also a current subject of investigation.

Naturally there are many more potentially important follow-up issues, but only those that seem within the scope of the immediate introduction of this prototype, as it is expected to be used in the McFarland schools during the near future have been discussed.

References

[AAAS 90] Project 2061: Education for a Changing Future, Report by the American Association for the Advancement of Science (1990)

[IBM 99] Operating System/2, IBM Corporation (1988)

[IBM 91] Presentation Manager, IBM corporation (1991)

Masullo, M. RHINO: A Curriculum Support System, Creating Learning Experiences IBM Research Report RC 18096 (1992)

Rutherford, J., Ahlgren, A. Science for all Americans, Oxford University Press (1989)

Acknowledgments

The author acknowledges that much of the information provided about the RHINO Model was taken from the yet unpublished document that describes it. That document is being written by the designers of that model, the educators in the McFarland, Wisconsin School District.

Paper (W3.7b)

Computer Assisted Video Instruction Of A Classical Indian Dance Form

Mythili Sridhar and James Levin
National Center for Supercomputing Applications
University of Illinois at Urbana-Champaign

Abstract

Recent advances in computer technology have paved the way for the easy incorporation of video into computer-based instructional material. This latest capability can extend computer-assisted instruction (CAI) to dynamic topics that can only be taught using video. This paper details issues involved with the requirements and development of a system for the computer based instruction of a dynamic topic such as Bharatanatyam, an Asian Indian classical dance form. Video is used to present animated sequences of each dance step from different angles and views. A pictorial index provides a convenient basis for navigating through the various movie segments of the step. A given video sequence is divided into a particular number of segments and a picture index for each of these segments is provided on the card. The concept of video quiz has been incorporated to assist students to compare their movements with that of an expert or teacher. This will not only ensure that the students understand how to perform each step, but also actually do it the correct way. The concepts of video based tutorial and quiz as demonstrated in this project find widespread use in the development of any video-based instructional system.

Introduction

The capabilities of computer-assisted instruction (CAI) development environments and authoring languages have rapidly changed in the last few years with the advent and continuous improvement of computational resources. The use of video (animated graphics) in CAI has spawned a new field called computer assisted video instruction (CAVI). The effects of video incorporation in instructional material has been the subject of extensive research. The Interactive Video Project at the Bank Street College [Char, Newman, & Tally, 1987],the effects on computer animation on adult learning [Riber, Boyce, & Assad, 1990], effect of graphic feedback on student learning [Surber & Leeder, 1988], the effects of interactive video enhanced instruction on the achievements of seventh graders [Levin, 1991], etc., offer insights into the relative merits and thought provoking questions on the wisdom of using video in CAI. While much debate (and research) is going on evaluating the effects, wisdom and merits of video incorporation to enhance traditional character based CAI, the area of developing video based CAI for topics that can *only* be taught with video has largely been ignored by the research community. Tennis and Ballet are good examples of topics that can only be taught using animated sequences of images (video).

In traditional CAI, the major portion of the instructional material is in the form of text characters, and video is used to enhance text based information. The computer assisted instruction of Tennis or Ballet, for example should use video as the primary avenue for presenting information while character based information is used to help the users navigate through the video information as well as highlight certain sections of video based information. The way computer-based instructional information is presented parallels the differences found in a live classroom. Ballet and Tennis are rarely taught using text books. The student learns these dynamic topics from watching an expert in action.

While it is very easy to see the merits of video incorporation in the CAI of dynamic topics like dance and sports, the question remains of the effectiveness of these CAI material. Students may be shown fantastic sequences of graceful dance or powerful tennis strokes. The crucial question then is how does the CAI evaluate student progress and offer feedback? CAI presents information to students in the form of images. A particular tennis stroke or a dance body posture is presented in an image form and is often supplemented with text. How can the student convey back to the computer what he/she has just learned? CAI can use the traditional multiple choice format: display four different images and ask the student to pick the right one. A drawback with this approach is that the student may know what exactly to do, but does the student actually do it the correct way? Assume for a moment that CAI is able to *see* the student in a particular body posture, compare this with the correct body posture and offer feedback. This kind of feedback can help the student correct mistakes and make learning very effective.

Golf improvement video tapes by Palmer and tennis instructional video tapes by Chris Evert are good examples of experts presenting their knowledge in video form. In most sports institutes, video taped analysis is a standard feature: in this, players are video taped in action. An expert and the student together analyze the video tape, evaluate areas requiring improvement and work on remedial course of action. Image based student response in CAI simply integrates the above two methods into a single system.

In this paper, we describe in detail the issues we encountered while attempting to design a CAI for the instruction of Bharatanatyam, a classical Asian Indian dance form. The problems, their solutions and the limitations of the present technology can be considered representative of those faced by CAI systems for topics involving dynamic change. A detailed analysis of the strengths and weaknesses of such a closed loop CAI system is also given. The results of this project extend the concepts of traditional text based CAI Tutorial and Drill to video based CAI.

Video-based Tutorial

The basic steps of a dance form or a sport can be presented in the form of video tutorial. The first step is to identify the basic steps (or building blocks to be presented). In a character based system, only a single layer of information is presented at a time. In a video tutorial, when images are presented in an animated sequence, several frames are shown per second to create the perception of motion. Since the images are presented quickly, there is potential for information loss. A video tutorial should at least consist of the following features:

- The tutorial should provide for easy navigation among frames in a single sequence. Suppose, a minute of video is presented at ten frames per second, the user should be able to go to any one of the six hundred frames.
- The tutorial should provide multiple views of the same item. Side, top or bottom views, close up of critical parts of the body movement, etc. should be available for review by the student.

Video Drill

In the area of sports and dance forms, drills are very important. Body postures, weight transfer and timing, etc., are acquired through repeated practice. A CAI based Drill can greatly aid the student in identifying how close he/she is to the desired body posture or timing. The expert (or ideal) image is the *correct* answer. The student is videotaped in a particular posture. This video clipping could consist of a basic dance step or in the case of tennis, the execution of a forehand drive. The following lists the requirements of an environment that will make the comparison of the expert and student images possible:

- Frame by frame access: the student should be able to control the expert image as well as the student image frame by frame. This helps identification of even small differences in timing.
- Coordination of Student/Expert images: If frame by frame access of both the images is available, the student can simply identify the starting point of the student image sequence based on the first frame of the expert image. The student can simply advance his/her image sequence to the frame corresponding to the first frame of the expert image. Since the expert image is also used in the tutorial, the student is already aware of the expert images. So she/he knows what (angles, part of the body, etc..) body posture to be in and tape as the student response to the video drill.
- Prompts for Comparison: upon displaying both the expert and student images, the CAI system should prompt the student to compare and contrast the important features. While the CAI system is authored, an expert in the field should be consulted to identify errors often committed in a particular topic and these factors should be included in the prompt.

Prototype Demonstration

The requirements for video-based tutorial and drill were enumerated in the previous sections. These concepts are illustrated in a computer aided instructional system for Bharatanatyam, an Asian Indian dance form. The first author has been involved in teaching and performing this dance form for the past fifteen years and the CAI material has been developed based on her personal experience. Video images have been collected from several sources including documentaries produced by the Indian Television. This project was developed using HyperCard and QuickTime.

Introductory features on the practical as well as theoretical aspects of the dance form have been included in this video-based CAI system. This is particularly important because the theoretical aspects are often overlooked in a dance class because there is not always enough time to teach them. This sometimes has serious repercussions because the students are unable to develop their talents beyond a certain level. The interested and committed students learn the theoretical aspects on their own from books. But here the student is not always sure how to pronounce many new *Sanskrit* terms (an ancient Indian language, which is not in use in the present day, most of the dance terms are *Sanskrit* based). In a computer based approach, the students can learn the theoretical aspects on their own. The sound portion of multimedia enables one to learn the correct pronunciation. The entire effort is to teach Bharatanatyam using a computer based hypermedia system. The goal was to study the advantages and disadvantages of teaching dance with the aid of a computer.

The program is composed of several stacks and each of which describe an aspect of Bharatanatyam. The first and second stacks give a brief introduction to Bharatanatyam. They explain the salient features, history and origin and the basic aspects. The third stack describes in some detail the various gestures involved in Bharatanatyam. These include hand and foot gestures, eye movements, etc.. All the gestures are explained with their meanings and pronunciations. Video images have been used to demonstrate the various gestures. Buttons to teach the pronunciation of names of gestures have also been included. The right way to keep hands or the correct body posture or the precise way to do a step cannot be learned from a book. The different uses of each gesture along with a video animation has also been included. This not only helps users learn these gestures, but also encourages them to indulge in elementary choreography. This will instill more confidence in them and provide a more motivating learning environment. The fourth stack covers another aspect of the dance, expressions. The content of these stacks was chosen based on the author's extensive experience first as a student and then as a teacher. The basic stacks were also tested on a selected group of Asian Indians with some knowledge about the dance form. Appropriate modifications were made to the basic stacks based on this preliminary testing.

The user has easy access to help menus at all times which makes using the program simple. The users can quit the program anytime and return to the program whenever they want to. The users can learn the dance at their own pace. Unlike the teacher who is not available at all required times, this program is. Also the detailed indexing enables the users to access whichever part of the program they want to look at.

At the end of each stack, short quizzes have been incorporated to familiarize and reinforce what the users have learned in that particular stack. If they answer incorrectly, they are given corrective feedback. Most of the questions are of a multiple choice nature. For example they may have been given the meaning of a particular word. They have to pick the right word from the choices given. If the users choose the wrong word, then they are given the meaning of the word they chose and then given another chance to choose the right word.

Special Features of the Video Tutorial

From the basic stacks, the users can click a button to review video images associated with a particular dance posture, step or facial expression. The video sequences are presented in the following format:

- Each dance step is presented using multiple movies. The nature of the multiple views was based on the complexity of the dance step involved.
- Initially, these multiple views are presented one at a time. The user thus becomes familiar with each movie.
- After becoming familiar with each of the different views (of the same step) the user is simultaneously presented with all the movies. This enables the user to become more familiar with the intricacies involved.

The above points are explored in detail in the following sections.

Navigating through a Single Video Sequence

The video movies provide a perception of motion. While this is required to learn a dance form, a slow motion perusal of the video sequence is also equally important. The user has two avenues to navigate through a video sequence. In the first method, the user is provided with a *pictorial index* of a sequence. By simply clicking on a particular picture, the user is able to see a small segment of the animated sequence pertaining to that part. This pictorial index method of navigating through a video sequence is illustrated in Figure 1. The series of small pictures at the bottom provide the pictorial index to the movie. The slightly bigger window in the top of the card is the area where the chosen segment of the movie is played. Buttons are provided at the bottom to choose any one of the multiple view pertaining to a single dance step. Figure 2 shows the foot work involved in the dance step shown in Figure 1. In the second method, a simple slider (controller) is provided at the bottom of the picture. By moving the slider the user can go to the desired frame. This method is illustrated in Figure 3.

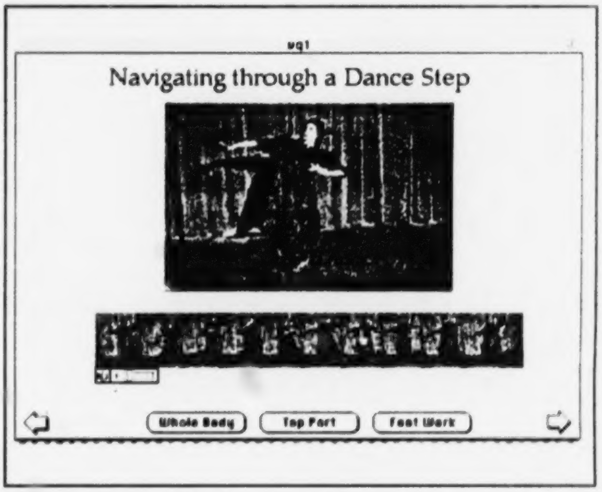


Figure 1. Pictorial index to a video sequence. The smaller pictures at the lower part of the card form an index to the animated sequence. By clicking on a particular picture, the segment pertaining to that picture is played on the larger window.

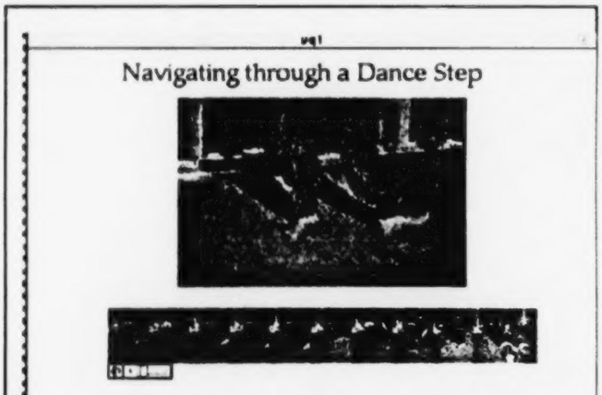


Figure 2. The buttons at the bottom of the card help select one of the three different video movies pertaining to a single dance step. The foot movement corresponding to the dance step shown in Figure 1 is shown here.

Multiple Views

Complex dance steps/postures are presented from several different views: the whole body from the front, side and back. Steps involving complex foot steps are additionally supplemented with a sequence concentrating only on the foot. In some cases, a movie of just the upper body movements is also included. The multiple views are presented on a single card, without a pictorial index but with a controller at the bottom of each movie. This is shown in Figure 3. The controller at the bottom of each movie lets a user navigate through the animated sequence. The user can navigate through the upper body sequence, and stop at a particular frame. He/she can use the controller on the foot work movie window to advance foot work movie to the corresponding frame. Thus the learner can be presented with a large number of multiple views of a single dance step. All the movies (views) can be made to advance frame by frame. Additional pictorial index can also be incorporated.

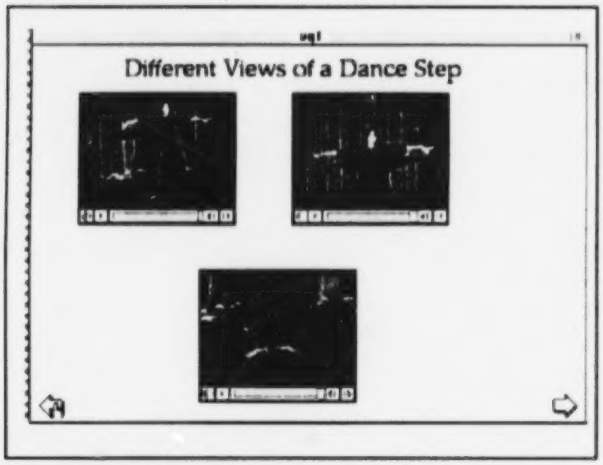


Figure 3. Simultaneous presentation of the three views pertaining to a single dance step. The controller at the bottom of the movie window provides frame by frame access to the movies. The number of different views presented varies with the complexity of the dance step.

Implementation of the Video Drill

The implementation of the video drill is shown in Figure 4. Buttons are provided to select the expert movie (the ideal or correct body posture) and the student movie for comparison. The two movies are displayed with controllers so that a user can navigate through each movie and compare frame by frame. The card shown in Figure 4 is the general frame work for the comparison of expert and student movies. During the final stages of this project and prior to its incorporation into a videodisk, each quiz will be customized. The customization will primarily be in the area of comparison prompts.

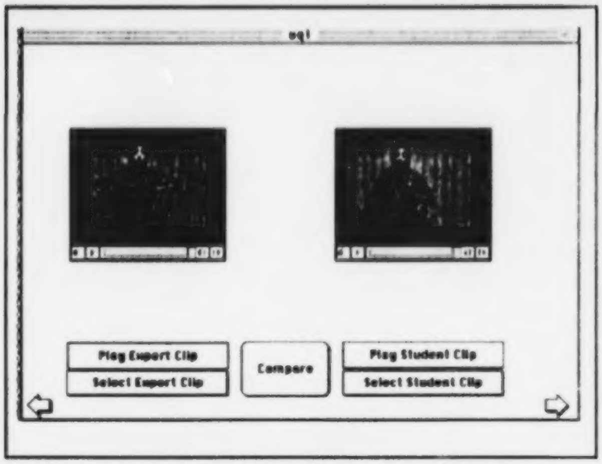


Figure 4. The general framework for video drill. The buttons are used to select and play expert/student movies. The controllers are provided to aid frame by frame comparison of the two movies. Because of these controllers, sophisticated time coding of the movies is not required to coordinate the two sequences.

The expert movie is the same as the one presented in the tutorial. Initially the student learns a basic step using this image, then the student is videotaped while practicing this step. This movie is digitized into the computer for comparison and evaluation. The steps to be video taped (in traditional CAI terms, the questions of the video quiz), will be presented at the end of each lesson. At the end of the lesson, the student is given a list of steps he/she should videotape and bring back to the CAI. Text based prompts are presented to aid the student in comparing his/her progress. This is shown in Figure 5. It can be seen that the student's elbows are not kept away from the body, and the text-based prompt makes sure that this point is not missed. The video-based drill provides an environment for the comparison of the two images as well as the factors that should be used in the comparison. A different form of prompting was also implemented. This made use of the sound capabilities of the Hypermedia. In the expert images, sound was incorporated to point out the most commonly made mistakes. When the expert movie is played, the voice prompts the students to compare certain features. One advantage of the text-based prompts is that the answers to these questions can be directed to an expert system and a more elaborate analysis of the mistakes can be carried out. This is an area for future research.

Technical Details

The images used in this project were taped using a regular VHS camera. (Some of the video clippings were taped from Indian TV broadcast in the PAL format. Video Spigot is capable of handling different TV formats). Images were captured at ten frames per second. (A higher frame rate will be used later during the production of the video disc. Most

Macintosh models can play back digitized video at ten frames per second or less).

Several compression ratios were experimented with. Most of the movies were compressed at either 2.5 or 3.25 (on a scale of 4, 4 being the original uncompressed image, 1 being the most compressed). The longest movie was about a minute. While an analysis of the different compression settings was attempted, it did not lead to any interesting conclusions. The file size depends on the complexity of the dance step. If there is lot of motion in a particular movie, the compression was not very effective. Each minute of video required approximately 6 megabytes of storage.

While the designing of the HyperCard based stacks takes careful consideration, the designing of the video sequences is also equally important. The lighting, combination of colors, the angle of view and the composition of the frame are factors requiring careful consideration. There is also a slight change in color when an object/person is taped using the VHS format. There is also a color shift going from VHS format to captured (digitized) video. A light or white background looks good both on VHS and in digitized form. Video editors can be used to create background effects. When different views of a single dance step were taped, each view required a separate lighting arrangement. For example, taping of the whole body movement and just the foot work of the same dance step required drastically different lighting arrangement. In the first case, the entire body is illuminated while the later requires concentrated light only on the feet. Very bright light focused on the feet also produce poor images. The best way to get a feel for this is to keep a careful record of all the light positions during the initial taping, experiment with different combinations, and then capture these images and decide on the best one. If multiple taping sessions are required, it may be better to use the same colored clothing. Care must be taken to avoid taping the shadow of the person being taped, since the shadows do not look good in captured images and severely degrade the quality of the captured image.

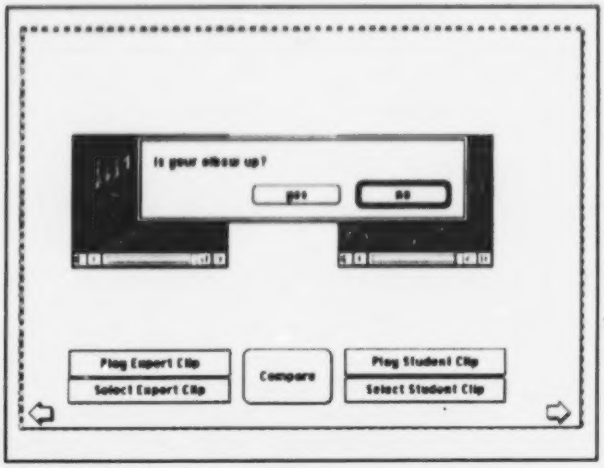

Is your elbow up?

Figure 5. Prompts for comparison. The button named compare activates the prompt dialog boxes for comparison. It is easily seen that the student (on the right) is not holding the elbow correctly. This is pointed out in the character based prompts. Voice based prompts have also been included in some cases.

Video Spigot allows one to capture sound simultaneously during video capture using the MacRecorder. During the videotaping period, in general it was difficult to work on the video and audio at the same time. Several attempts were required to make a single video recording. Incorporation of sound into these movies added to the complexity. Since video editors allow for easy incorporation of sound at a later time, it may be better to separate the sound and video recording as well as capture. In situations were the movie was captured from a performance tape or a TV documentary, capturing sound and video at the same did not prove to be a problem.

Strengths of video-based CAI

Images are a logical extension of text. In one sense an image can be thought of as simultaneous (parallel) presentation of many characters. The technology permits the inclusion of image based student responses, which greatly enhances the capabilities and applicability of CAI. A picture is worth a thousand words. For the description of body movements, even thousand words are not enough.

The video presentation has been designed to incorporate the teaching strategies followed by an instructor in a class. For example, when teaching a hand movement, the instructor will show that movement part by part, clearly specifying where and how each hand is placed at each part. However, due to time constraints and the number of students in the class, the instructor will not be able to demonstrate a movement in detail more than two times. In complex steps, the student may forget what was taught in class. In such situations, the video-based tutorial offers enormous amount of help. The video-based CAI also frees the instructor from having to repeatedly demonstrate the same step and instead use the time for more creative topics.

- The instructional video can be watched frame by frame. Thus critical timing errors can be easily understood and eliminated.
- The drill part offers valuable feed back. The student can progress at his/her own speed and does not have to wait for an instructor to analyze his/her progress.
- The quality of feedback is also greatly improved because experts in each field can be consulted during the initial stages of the design. Students who do not have physical access to these experts can still utilize the experience of these experts through CAI.

Economics

Video-based instructional tools have been used for a long time. Professional sports teams and premier dance companies have used them for a long time. The introduction of VCRs in the late 70s has resulted in a wide selection of instructional (mostly game improvement) videos for the individual household. These videos do not offer feedback. In order to compare and analyze, at least two TV monitors and VCRs are needed. For the price of an extra VCR/TV combination, an existing personal computer can be easily upgraded with extra memory and a video capture card. For less than a thousand dollars, an *existing* computer can be upgraded to handle all of the above mentioned features of video tutorial and drill. Almost all sports clinics offer videotaped analysis. A computer assisted analysis will greatly enhance the quality of the feed back offered. With CAI, the student can spend as much time as he/she needs and can go through the analysis at his/her own pace.

Conclusion

A video-based CAI system for Bharatanatyam, an Indian dance form, has been described. Many of the issues faced during the design of such a system can be considered as representative of problems associated with the design of video-based CAI for any topics dealing with dynamic change. The preliminary implementation has clearly demonstrated that image-based CAI is a very effective teaching tool in the fields of dance and sports. The technology is in the early stages of development and given the characteristic rapid progress in the computer field, image-based student responses in CAI should become very economical to use in a few years. Rather than waiting for such a time, we can start to work on prototypes and transfer the knowledge gained from such prototypes to widely used products in the future.

The concepts of video-based tutorial and drills have been described and their characteristics briefly discussed. The attributes of video tutorial and drill covered in this paper can be used as general guidelines in the development of other video-based instructional material.

References

Char, C., Newman, D., & Tally, W. (1987). Interactive Videodiscs for children's learning. In R. D. Pea & K. Sheingold (Eds.), *Mirrors of minds : Patterns of experience in educational computing* (pp. 223-241). Norwood, NJ: Ablex Publishing Corporation.

Levin, S. (1991). The Effects of Interactive Video Enhanced Earthquake Lessons on Achievement of Seventh Grade Earth Science Students. *Journal of Computer-Based Instruction, 18*(4), 125-129.

Riber, L. (1990). Animation in computer based education. *Educational Technology, Research & Development, 38*(1),77-86.

Riber, L., Boyce, M., & Assad, C. (1990). The Effects of Computer Animation on Adult Learning and Retrieval Tasks. *Journal of Computer-Based Instruction, 17*(2), 46-52.

Riber, L. & Kini, S. (1991). Theoretical Foundation of Instructional Applications of Computer-Generated Animated Visuals. *Journal of Computer-Based Instruction, 18*(3), 83-88.

Surber, J. & Leeder, J. (1988). The Effect of Graphic Feedback on Student Motivation. *Journal of Computer-BasedInstruction}, 15*(1), 14-17.

Paper (W3.7c)
Student-Produced Hypermedia as an Empowering Tool

Roger Volker
Iowa State University
Ames, IA

Abstract

When students create hypermedia projects to manifest what they know about a subject they learn to communicate in new ways and they learn how to use contemporary technology too. Their ability to manipulate computers, graphics, sound, and videodiscs provides a competetive edge over students who merely read-a-book, write-a-paper, and take-a-test.

Introduction

This paper describes a method for using hypermedia (interactive multimedia) as a means of fostering a new form of learning among elementary, secondary, and college students. Rather than positioning them as consumers of prepared computer-based instruction, they are asked to be producers of programs. This shift of focus heightens interest, increases competence with instructional technology, and fosters constructivism—that school of thought postulating that learning takes place only when learners develop new constructs on their own. By producing hypermedia packages in traditional content areas such as science or language arts, for example, students must organize and then portray their own versions of the structure of knowledge. These creative activities provide a sense of worthwhileness that can lead to empowerment. By using HyperCard or HyperStudio, sound digitizers, and laser videodiscs a collection of unique and specific applications can be designed by teachers and students, working together. The resulting products serve two purposes. They add to the bank of learning materials that a teacher can use in class, and they provide students opportunities to communicate ideas using contemporary technology as alternatives to "read-a-book," "write-a-paper," and "take-a-test."

Because of the differences between student-centered production of hypermedia programs and teacher-centered computer-based instruction it will be helpful to briefly review what is meant by "computer-based instruction" or "computer-assisted instruction."

A Look at Traditional Computer-Based Instruction

Traditional uses of the computer as an instructional tool focus on lessons that teach, mirroring what happens in a live classroom. Teachers provide information, ask questions, furnish feedback, and often branch their teaching in an attempt to tailor instruction to the needs of the student who is answering the question. Alternative explanations and analogies or examples are sometimes invented on the spot to help students understand concepts. Live instruction may be characterized as a series of "frames" that contain information, a question, a student answer, and some sort of feedback.

When computers arrived in classrooms it was naturally tempting for teachers to see these new machines, with their large memories, as a cadre of well-informed teachers. Computers could provide all kinds of information, ask a wide variety of questions, diagnose how right or wrong the answers were, and then branch to customize the continued instruction. Students were thus "taught" with the computer, following a model that resembled live classroom instruction. Certain programs or computer-assisted instruction "lessons" were assigned for them to "do" or "take."

As teachers and students begin to use Hypercard, HyperStudio, Linkway, and other similar software a new vision of the microcomputer as an educational facilitator has begun to emerge.

A New View of Computer-Based Instruction

After the initial burst of drill and practice programs, tutorials, simulations, and other CBI, some educators have begun to view the computer as a different type of "teaching machine." Rather than merely provide ready-made lessons it is seen as a production device—a tool for thinking, an intelligence amplifier, a hypothesis tester. Learning happens when students make hypermedia programs on the environment, on the cell, on the life of a famous person. The product that results could be consumed by someone else and they would learn from it. But learning takes place for the producer in the making of the project—in the selection of the topic, the organization of the ideas, the consulting of references, the search for appropriate sounds, pictures, line drawings, videotape, and other media.

This creative endeavor of making something new is not unique to computers. It happens when writers write, when artists paint, or when musicians compose. A comparison between computing and music illustrates levels of sophistication that differentiate producers of ideas from consumers of ideas. Even though a concert pianist must possess a great deal of understanding about music, and also must be a technical

	Music	*Computing*
Novice	Knows names of notes, time signatures, treble and bass clefs	Has keyboarding skills, knows how to use a mouse, pull-down menus
Expert	Performs compositions of others	Is proficient with word processing, databases, spreadsheets, desktop publishing, graphics
Composer	Writes original music to be performed on a single instrument	Writes programs in a specific language
Orchestrator	Develops a musical score for many different instruments	Creates interactive multimedia using sound, graphics, scanned images, videodiscs, etc.

expert, an even higher level of musical insight is needed to compose a symphony and then write the score for all of the instruments in the orchestra.

In a similar fashion, a student who learns enough about insects to create an interactive multimedia program about them may acquire a deeper understanding than one who merely reads the insect chapter in a book.

The above comparison between music and computing illustrates four levels of expertise, ranging from a knowledge of how someone else's work is done to a capability to produce original work.

Why Hypermedia?

Emerging developments in hypermedia have attracted attention because of the wide variety of technology that can be packaged together to make learning exciting and stimulating. A number of commercially available programs, such as *Election '88*, *The National Gallery of Art*, and *Bioscience* are already in use in classrooms. These programs, and others like them, are Hypercard-based and incorporate a variety of important teaching and learning characteristics, including:

- Nonlinear format—the user can explore ideas, consult data bases, and "consume" the content with complete freedom, following hunches and testing hypotheses at will.
- Interactivity—software is user-driven, with choices, paths, and areas of exploration entirely under the control of the user. Answers to questions, calculations, pictures, sounds and other responses of the computer-based system are provided on demand.
- Multimedia—laser videodiscs, digitized sounds, and verbal information from the computer or a CD-ROM are available, and managed by the computer under the direction of the user.
- Self-pacing and user convenience—because the computer won't do anything unless you take some action, the pace of consumption of the material is up to the user. Access to information and guidance for the activities is right there on the screen, through the intuitive use of icons that you design.

The number of commercially available hypermedia-based programs is increasing, and they are becoming more and more sophisticated. And they do foster nonlinear use, providing for free exploration based on the learner's interests. However, the intent is still to "teach" because they presume that students will acquire new information from the program.

Empowering Students

Many of us teach by following organized, systematic lesson plans. We tell students what they need to know. They complete assignments we make. This is teacher-centered education, leaving little freedom for students to choose what interests them, and providing them with little power or few options to use in the learning enterprise. On the other hand, students who are given responsibility for their own learning are empowered with a lifelong capability.

Thus it is important to give students the freedom to decide which directions to take as they explore an area of content. *They* should choose what to do next, under a teacher's guidance. With a "starter package" of information (texts, articles, photos, videotapes, videodiscs) and software to organize a database (Hypercard, HyperStudio, etc), students are free to invent the treatment, scenario, or approach needed to orchestrate the material.

Goals and Objectives

The overall goal is to create an atmosphere in the classroom that creates an air of expectation and a sense of excitement for selected areas of content on the part of both teachers and students. Some of the objectives to be reached by teachers and students include:

- To identify new methods of articulating ideas
- To learn how to use a variety of technology to express ideas
- To develop problem-solving approaches through hypothesis testing
- To foster a collaboration among teachers and students, and cooperative learning among students

- To provide motives for students to use many knowledge bases: texts, videodiscs, CD-ROMs, etc.

Organizing a Project

The design and production of hypermedia projects is usually a small group enterprise at the classroom level, with occasional leadership and some instruction provided by others. (Opportunities to use community resources may arise, involving parents, students in other schools, or citizens with expertise in computing or in the content area). Responsibilities of the production team and their teacher are described below:

- Production team—students who will identify, produce, and field test the hypermedia projects. Each project will have a production team headed by the local teacher who, in turn, selects a few students from that school who are involved in production of the materials.
- Teacher—assists the production team in terms of content and by providing technical expertise in using the computer. The use of outside resources such as equipment or reference materials may also be facilitated by the teacher.

Description of Typical Projects

The following examples show how HyperMedia might be created to facilitate a teacher's instruction (teacher-centered) or to facilitate student learning (student-centered).

- Ms. Brown, a biology teacher, needs a ready reference to pictures of plants and animals in their native habitat. The images are on a commercially available videodisc but there is no computer-based (HyperCard) program to organize and find selected pictures. Brown and some students would like to make a computer-managed program that would permit any students to look up plants and animals by common name, by scientific name, or by type of habitat.
- Bill and Sally, math students, have been asked to "...write a paper" about "Geometry in Our Lives." They have found some examples of various geometric shapes in a videodisc called *Dream Machine*, a disc that shows examples of computer-generated graphics. They would like to create a computer-based project with the disc that shows examples and explains their relevance to our lives.
- Mike and Martha, friends of Bill and Sally, also were assigned the geometry paper, but M&M want to make a videotape that highlights various architectural features of buildings in their town (historic preservation is a biggie where they live). Using HyperStudio's video overlay feature, the sound digitizer, and the scanner they want to make a videotape that describes how a knowledge of proportion in geometric figures is a key concept in the design of structures.

Steps in Producing Hypermedia Projects

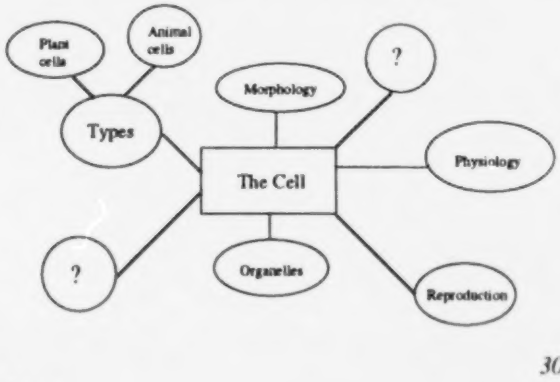
1. *Select topic.* Members of the hypermedia production team will need to identify a topic that is sufficiently interesting and appropriately sized. Students and teachers will need to work together to establish realistic boundaries for the project. For example, work in science might include phylogenetic comparisons, taxonomic schemes, a study of environmental or ecological issues, or set-ups for experiments that can be "dry-labbed" on the computer. In math, the videodisc "The Physics of Automobile Collisions" could be used to study vectors, or "The Puzzle of the Tacoma Narrows Bridge Collapse" would provide application of arithmetic, algebra, or pre-calculus to an investigation of sinusoidal wave motion. Browse videodiscs, texts, and a variety of computer programs for ideas.

The following guidelines are suggested during this selection process:

- Examine videodiscs and videotapes to determine what ideas, feelings, or attitudes they might suggest
- Determine what skills or content areas could be addressed by pictures or drawings that pertain to the topic
- Remember the need for students who are producing the hypermedia program to take leadership and responsibility for the overall project
- Analyze the need for hypermedia in the project. (Would printed material, a videotape, a photo essay work as well?)

2. *Identify Goals and Objectives.* Formulate a statement that describes what the user should be able to do after using program. Members of the production team should also identify the benefits they believe will accrue to them as a result of working on the project.

3. *Specify Program Architecture/Model/Block Diagram/Cognitive Map.* Make a drawing using circles or rectangles connected with lines to represent the relationships among the components of your program. For example, suppose the topic is *The Cell*. A concept map should indicate the relationships that might be included in a hypermedia program on the cell. One example of that map is shown here:



BEST COPY AVAILABLE

4. *Develop Storyboard or Flowchart*. Storyboards resemble comic strips or comic books, and they are used in film production. Graphic artists draw scenes to help the director plan various shots and to gain understanding of what the finished production will look and sound. In a similar manner, a storyboard should be made for a hypermedia production to show how the program will flow, and to indicate the relationships of the parts. Because a hypermedia program consists of specific screens of information that involves words, graphics, scanned images, or sound effects. Hypermedia storyboards are a screen-by-screen sequence that depicts the entire program.

The hypermedia storyboard begins as a sequence of hand-drawn sketches, pasted on a large sheet of paper; 3x5 cards work well to represent the screens of information. If HyperCard is the software being used, for example, the design on each 3x5 card will become a card in the HyperCard stack as text and graphics are produced. Finished cards in the HyperCard stack can be printed and pasted into the flowchart to replace the original, hand-drawn sketches.

Some elements to consider in the production of the hypermedia project include:

- Use of motion (videodisc or videotape)
- Use of stills (scanned graphics or digitized video frames)
- Verbal information on the computer screen
- Audio—recordings of voice, music, or both—or prerecorded audio from the videodisc or tape

5. *Make a Working Shell.* Make a program shell that is not fancy, but which runs and allows you to move throughout the stack and access video and sounds in the ways you had anticipated. Leave some buttons nonfunctional, use words on a card to indicate "Tree goes here," and so forth. The main menu and basic screen design should be worked out so that additional features can be completed later, by other students.

Evidence of Empowerment

Members of the educational community who have followed the approach described in this paper have expressed positive opinions about the benefits. Students like it because of the opportunity to use high technology and to play a larger role in making decisions about their own learning. In a number of cases these students have served as mentors to a wider circle of students, teaching them skills with computers and the associated peripherals.

Teachers find that students appear to be more highly motivated—not only to use technology, but to examine a wider variety of resources in the school media center. On the question of assessment, hypermedia projects may bring out skills that are rarely seen in traditional teaching—such as organizational ability, interpersonal relationships, and a knack for the use of technology.

References

Bodner, George M. (Oct. 1986). Constructivism: A Theory of Knowledge. *Jl. of Chem. Ed.* Vol. 63, No. 10.

Dede, Christopher. Empowering environments, hypermedia and microworlds. *The Computing Teacher*. Nov. 1987.

Volker, Roger. (1992). Application of Constructivist Theory to the Use of Hypermedia. *Proceedings of AECT Research and Theory Division*, 14th Edition.

Von Glasersfeld, Ernst. (1981). The Concepts of Adaptation and Viability in a Radical Constructivist Theory of Knowledge. In *New Directions in Piagetian Theory.* Irving Sigel, Ed. Lawrence Erlbaum Associates, Hillsdale, New Jersey.

Projects (W3.8)
Instructional Software

Integrating Educational Technology and Elementary Mathematics Curriculum

Betty Bjork, Dan Dick, and Kim Benson
Elementary Mathematics Center
Newton, MA

Abstract

This presentation describes the Elementary Mathematics Project at the EDC, a large-scale innovative K-6 curriculum and software development effort which integrates exploratory software environments with video and concrete manipulative materials in a new elementary math curriculum. Our goal is to use technology to support teachers and students in fully implementing the Curriculum and Evaluation Standards of the National Council of Teachers of Mathematics. Each participating classroom includes a network of five computers which are used primarily as tools to foster mathematical investigations and problem solving.

We will describe our educational philosophy and approach to software and curriculum design and demonstrate materials related to three curriculum strands: geometry, patterns and relationships, and probability and statistics. The session will include demonstrations of software and video materials along with a videotape showing students using these approaches.

The Education Development Center is a non-profit corporation conducting educational research and development.

This abstract was taken from the author's originally submitted proposal

Infortissimo: Music With The Computer

Paul Jansen
National Institute for Curriculum Development
The Netherlands

Abstract

This session is aimed at the role of computers in the subject of music for children ages 10 to 14. Among the themes discussed will be timbre, rhythm, structure, style, film music, and ethnic music.

This abstract was taken from the author's originally submitted proposal

It's A Small World - Project Make A Difference

Donna Rosenberg
Boston Public Schools
Boston, MA

Abstract

Every school has at its foundation the desire to make good citizens of its students. This project's primary focus was to make children cognizant of their ability to make a difference, to become aware of the outside world, thereby becoming citizens of a larger community other than their immediate family and neighborhood. It is a small world after all.

The three skills incorporated in this project were: technology, art, and language. In a world becoming more and more technological, our elementary students learned to use various technological tools: computer, scanner, printer, binder, and Xerox, and to feel comfortable with accessing and using these tools. Students at the Patrick J. Kennedy Elementary School collaborated within their classrooms and across grade levels to produce coloring books which were donated to Boston City Hospital's children's unit.

A video from the brainstorming sessions to the finished product will be shown.

This project was funded by a grant from the Bank of Boston School Initiatives Grants Program and is a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Linking Technology with Thematic Unit on Endangered Species

Shelley B. Wepner and Nancy E. Seminoff
The William Paterson College of New Jersey
Scotch Plains, NJ

Abstract

The promises and pitfalls of integrating software into a thematic unit on endangered species for primary students will be presented. Software has been identified to support the activities for six content areas within the unit. For example, as students learn about different animal characteristics for science, they are using "Backyard Zoo Games: Animal Album and Guess My Animal" from *The Treehouse* to reinforce their understanding of how animals are classified or grouped together by traits.

Once procedures for identifying curriculum-relevant software for this unit are discussed, we will provide information collected in the following ways: (a) teacher's anecdotal records of students' progress; (b) teacher's journal writing; (c) portfolio samples of students' writing; and (d) students' response journals to software experiences. The teacher's overall reaction for using software for a thematic unit will be discussed in the context of working with 1-2 computers in the classroom. Guidelines for integrating technology into the curriculum will be presented as a result of first-hand observations and face-to-face interviews with the teacher responsible for field-testing this project.

Projects (W3.9)
Restructuring

Implementing New Technologies: Collaborative Research in a Middle School Setting

Leslee Francis, Ted Riecken and Pierce Farragher
University of Victoria
Victoria, BC

Abstract

This project describes elements of a three way partnership involving a university, a middle school, and a government sponsored technology centre in Canada. The school, with 725 students, was built with government funding to be a model school incorporating technology as an integral part of the education process.

University faculty are working with personnel from the school and the technology centre to develop materials and processes to help teachers across the province integrate technology into classroom instruction. Several staff development models have been used to help develop staff expertise in educational technology. These include:

1) inservice on a variety of software including word processing, databases and spreadsheets, HyperCard, graphics programs, and multimedia applications;

2) an expert peer program in which teachers learn from school based colleagues;

3) an action research program in which school staff work with university personnel to investigate practical problems relating to computer use.

This presentation focuses on action research conducted by teachers as they learn to make extensive use of computers in their classrooms. Projects to date include using HyperCard in social studies, computers/ cooperative learning in science, computers in French immersion, and impact of computer use on classroom interaction. Data on classroom use of computers (teaching, management, student tool) will be included.

Improving Student Performance Through Technology

Darylann Hansen
Beaumont Independent School District
Beaumont, TX

Abstract

Fundamental changes are being demanded of our educational system. A restructured school is a "smart" school — one that allows students and teachers to play new roles. When facing the complex challenge of restructuring education through the use of technology, diverse viewpoints are critical. Staff coordination and planning are key to making change happen. Technology both empowers and expands the roles of students, teachers, and administrators. Technology can also be used as a vehicle in achieving campus and district goals.

This session will focus on collaborative planning for the dynamic uses of technology in a changing, restructured school district with the goal of improving student performance. Beaumont ISD is a district of 21,000 students located in Southeast Texas. The district developed a five-year technology plan addressing both administrative and instructional requirements that resulted in the integration of technology from the classroom to the district office.

Topics to be discussed include technology-related planning, funding and staff development activities, expansion of telecommunication networks, multimedia applications, development of technology-based assessment tools, assurance of equitable access to technologies for learning, and commitment to quality. Other considerations include technology support, implementation strategies, evaluation, protection of individual privacy, hardware and software standards, the protection of the district's investment, the major benefit derived, and a vision of the future.

This abstract was taken from the author's originally submitted proposa

Transforming the K-12 School: The Summit Experience

Ken Uckotter
The Summit Country Day School
Cincinnati, OH

Abstract

At The Summit Country Day School in Cincinnati, Ohio, we are utilizing computer technology in exciting and creative ways and are transforming our K-12 school. We've had wonderful success in our school of 950 students, and we have much to share about our program philosophy and approach.

Our graduates are confident in the skills they've acquired at our school. Key among the skills we have provided are: information management, writing, and desktop publishing. Our students are developing lifelong learning skills that will help them communicate effectively in our information society.

Macintosh and IBM computers on a fiber optic Ethernet network across our campus help us extend our learning resources to each of our students and classrooms. Supercomputer projects in conjunction with the Pittsburgh Supercomputing Center have offered unique opportunities for some of our students to participate in scientific research projects and life on the internet.

Our K-12 school is being transformed and the technologies employed are having a dramatic and energizing effect on our school! Examples from primary grades through high school will be related. We'll share our approach and techniques.

Projects (W3.10)
Multimedia

Quick Curriculum Connections With QuickTime

Sheryl Abshire, Diane Manson, and Barry Humphfus
Calcasieu Parish School System
Lake Charles, LA

Abstract

Curriculums come alive through the use of Apple Computer's newest multimedia technology, QuickTime. This project presentation by educators actively involved in innovative applications of the technology will highlight the uses of this software in various curriculum areas. Participants will see examples of actual student-produced QuickTime projects. A special treat will be viewing a HyperCard stack utilizing actual footage of the devastation of Hurricane Andrew along the Florida and Louisiana coasts. Presenters will provide relevant applications of the technology and handouts that detail step-by-step procedures to create original QuickTime videos.

This project presentation material is currently a non-commercial venture.

This abstract was taken from the author's originally submitted proposal

Florida's "Tech Team" Helps Schools Improve Through Technology

Lynn Cullum, Jack Edwards, Steve Newhouse, Pete Lenkway, Susan Schmid, and Donna Riley
University of Central Florida
Orlando, FL

Abstract

In order to assist teachers in using technology in Florida's schools, six experienced educators were hired as traveling "technology facilitators" through a grant from the Florida Department of Education. Lynn Cullum, Jack Edwards, Steve Newhouse, Pete Lenkway, Susan Schmid, and Donna Riley comprised the new "Tech Team," a free resource which was coordinated by the UCF/DOE Instructional Technology Resource Center. The facilitators worked with large and small groups, as well as with individuals, in utilizing videodiscs, CD-ROM, multimedia, computer software, FIRNMAIL, and SUNLINK. Tailoring their schedules and methods to meet the needs of the schools they served, the Tech Team members provided personalized service which allowed educators to feel comfortable with new and seemingly formidable technology tools.

Designing Issues for Development of Constructivist Hypermedia: The Wetlands Project

Diane McGrath, Hilary McLellan, and Mark Viner
Kansas State University
Manhattan, KS

Abstract

From the constructivist point of view, hypermedia is the tool of learners rather than the tool of the teacher or an unknown instructional designer. In the Wetlands Project, learners construct their representation(s) of their understanding of water and habitat issues by exploring published videodisc materials, a videodisc of *Cheyenne Bottoms* (under development), and HyperCard stacks providing both written material and access to video "note-taking." Students then go beyond this more typical (exploratory) classroom use of hypermedia to take real field trips in their own region, do interviews, collect data, and make QuickTime movies from videotaped samples of their findings. The result is a hypermedia combination of the exploratory and the constructive, an electronic document which connects the local to the global, the newly discovered to the established, what they read and see to what they know personally from experience. At a personal level, what they are learning becomes important and meaningful. At a more theoretical level, new learning is connected to the old to tune or restructure these schemata.

The presenters will discuss the constructivist philosophy of using instructional hypermedia, and practical and theoretical issues involved in this approach. They will discuss design issues for the creation of constructivist tools. And the most recently developed knowledge-building tools will be demonstrated (aids to create multimedia field trips, arguments, presentations, stories, and puzzles for other students).

This project is currently a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

---

Windows on Science In The Elementary Classroom

Raymond Fehr
Jefferson County Public Schools
Louisville, KY

Abstract

Today, more than ever before, the challenge of designing curriculum that meets the unique needs and interests of students rests in the hands of the classroom teacher. The Kentucky Reform Act mandates that schools develop their own curriculum that supports all students in their achievement of the valued outcomes. This presentation will demonstrate how one group of elementary science teachers is meeting that challenge, and they are doing so without a textbook. The catalyst for the science expeditions that will be shared is the Optical Data Corporation's videodisc series *Windows on Science*.

As a result of the Kentucky Reform Act, six learning goals, with seventy-five valued outcomes that frame these goals in measurable terms, were identified by the Council on School Performance Standards and approved by the Kentucky State Board of Education. While the valued outcomes are not curricula, they lay the foundation for determining curricula and served as our guide. *Windows on Science* provided our primary resource. Each lesson is rich in multisensory strategies and meets the needs of all students. Active learning and relevant assessment are an integral part of the instruction.

The curriculum created by the teachers, entitled *Viewing the World through Windows on Science*, demonstrates the power of videodisc technology in a variety of teaching situations. Random access to the visuals allowed the teachers to sequence the visuals they wished and empowered them to create lessons perfect for their situation. Following the philosophy that "less is more," thematic units on sound, animals, conservation, and landforms were designed to investigate topics in depth.

Electrifying, thrilling, and exhilarating describe the atmosphere of the teachers and students working with *Windows on Science*. Participants will journey through a sample lesson and receive a sample unit as they become acquainted with the components of *Windows on Science*. They will hear responses and reactions of both teachers and students and see first hand what *Windows on Science* can do for teaching and learning that is not possible with a text. Participants in this session are invited to share this experience and join the excitement as they view the world through *Windows on Science*.

This project presentation is currently a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Projects (W3.10)
Multimedia

Quick Curriculum Connections With QuickTime

Sheryl Abshire, Diane Manson, and Barry Humphfus
Calcasieu Parish School System
Lake Charles, LA

Abstract

Curriculums come alive through the use of Apple Computer's newest multimedia technology, QuickTime. This project presentation by educators actively involved in innovative applications of the technology will highlight the uses of this software in various curriculum areas. Participants will see examples of actual student-produced QuickTime projects. A special treat will be viewing a HyperCard stack utilizing actual footage of the devastation of Hurricane Andrew along the Florida and Louisiana coasts. Presenters will provide relevant applications of the technology and handouts that detail step-by-step procedures to create original QuickTime videos.

This project presentation material is currently a non-commercial venture.

This abstract was taken from the author's originally submitted proposal

Florida's "Tech Team" Helps Schools Improve Through Technology

Lynn Cullum, Jack Edwards, Steve Newhouse, Pete Lenkway, Susan Schmid, and Donna Riley
University of Central Florida
Orlando, FL

Abstract

In order to assist teachers in using technology in Florida's schools, six experienced educators were hired as traveling "technology facilitators" through a grant from the Florida Department of Education. Lynn Cullum, Jack Edwards, Steve Newhouse, Pete Lenkway, Susan Schmid, and Donna Riley comprised the new "Tech Team," a free resource which was coordinated by the UCF/DOE Instructional Technology Resource Center. The facilitators worked with large and small groups, as well as with individuals, in utilizing videodiscs, CD-ROM, multimedia, computer software, FIRNMAIL, and SUNLINK. Tailoring their schedules and methods to meet the needs of the schools they served, the Tech Team members provided personalized service which allowed educators to feel comfortable with new and seemingly formidable technology tools.

Designing Issues for Development of Constructivist Hypermedia: The Wetlands Project

Diane McGrath, Hilary McLellan, and Mark Viner
Kansas State University
Manhattan, KS

Abstract

From the constructivist point of view, hypermedia is the tool of learners rather than the tool of the teacher or an unknown instructional designer. In the Wetlands Project, learners construct their representation(s) of their understanding of water and habitat issues by exploring published videodisc materials, a videodisc of *Cheyenne Bottoms* (under development), and HyperCard stacks providing both written material and access to video "note-taking." Students then go beyond this more typical (exploratory) classroom use of hypermedia to take real field trips in their own region, do interviews, collect data, and make QuickTime movies from videotaped samples of their findings. The result is a hypermedia combination of the exploratory and the constructive, an electronic document which connects the local to the global, the newly discovered to the established, what they read and see to what they know personally from experience. At a personal level, what they are learning becomes important and meaningful. At a more theoretical level, new learning is connected to the old to tune or restructure these schemata.

The presenters will discuss the constructivist philosophy of using instructional hypermedia, and practical and theoretical issues involved in this approach. They will discuss design issues for the creation of constructivist tools. And the most recently developed knowledge-building tools will be demonstrated (aids to create multimedia field trips, arguments, presentations, stories, and puzzles for other students).

This project is currently a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

---

Windows on Science In The Elementary Classroom

Raymond Fehr
Jefferson County Public Schools
Louisville, KY

Abstract

Today, more than ever before, the challenge of designing curriculum that meets the unique needs and interests of students rests in the hands of the classroom teacher. The Kentucky Reform Act mandates that schools develop their own curriculum that supports all students in their achievement of the valued outcomes. This presentation will demonstrate how one group of elementary science teachers is meeting that challenge, and they are doing so without a textbook. The catalyst for the science expeditions that will be shared is the Optical Data Corporation's videodisc series *Windows on Science*.

As a result of the Kentucky Reform Act, six learning goals, with seventy-five valued outcomes that frame these goals in measurable terms, were identified by the Council on School Performance Standards and approved by the Kentucky State Board of Education. While the valued outcomes are not curricula, they lay the foundation for determining curricula and served as our guide. *Windows on Science* provided our primary resource. Each lesson is rich in multisensory strategies and meets the needs of all students. Active learning and relevant assessment are an integral part of the instruction.

The curriculum created by the teachers, entitled *Viewing the World through Windows on Science*, demonstrates the power of videodisc technology in a variety of teaching situations. Random access to the visuals allowed the teachers to sequence the visuals they wished and empowered them to create lessons perfect for their situation. Following the philosophy that "less is more," thematic units on sound, animals, conservation, and landforms were designed to investigate topics in depth.

Electrifying, thrilling, and exhilarating describe the atmosphere of the teachers and students working with *Windows on Science*. Participants will journey through a sample lesson and receive a sample unit as they become acquainted with the components of *Windows on Science*. They will hear responses and reactions of both teachers and students and see first hand what *Windows on Science* can do for teaching and learning that is not possible with a text. Participants in this session are invited to share this experience and join the excitement as they view the world through *Windows on Science*.

This project presentation is currently a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Creating Multimedia Magic in the Classroom

Linda M. White
IBM/EduQuest
Highland Beach, FL

Abstract

In every era, innovative people have used the available technologies to shape their own future. Today, modern communication tools are changing the way teachers and students interact with each other in the classroom. Multimedia is the technology, and easy-to-use authoring and knowledge systems are the tools that will empower our teachers and equip our students to be successful in the twenty-first century.

This presentation will focus on giving participants a clear understanding of Multimedia technology and an exciting demonstration using ***LinkWay Live!*** video into curriculum-based applications. The magic of Multimedia is truly a reality today and can help maximize the potential of everyday learning experiences in the classroom!

Projects (W3.11a)
Multimedia

The Teacher's Partner: Developing Multimedia for the Foreign Language Classroom

Stacie Hibino, Lynda Milne, Edna Coffin, Jerome Johnston
University of Michigan
Ann Arbor, MI

Abstract

The purpose of Project FLAME (Foreign Language Applications in the Multimedia Environment) is to design, develop, and research new multimedia learning environments for foreign language classes. We are currently developing applications in Spanish, French, Hebrew, and Chinese, and we are beginning some development in Russian and Polish. These applications are being tested in various educational settings, including: two collaborating high schools, one community college, an ethnic community day school, and one four-year university.

In this project presentation we will demonstrate one of our Spanish applications from the Mexico Vivo series. This application is in the format of one of our pedagogical models called the Teacher's Partners (TP). The TP is designed to enhance communicative activities in an otherwise traditional classroom setting. In this model, the teacher has one computer equipped with some form of presentation device (e.g., a very large screen monitor). The teacher controls the computer with a mouse and uses it interactively with the students. The TP includes access to three working modes: video, text, and activities. It enables the teacher to bring authentic culture and language into the classroom without necessitating radical changes to teaching style or curriculum. In addition, the TP provides an introduction to the use of computers and educational technology to the teacher and the students.

de-

The Magical Mystery Tour

Tina Petrone, Edward Kelberg, and Sam Williams
South Philadelphia High School
Philadelphia, PA

Abstract

In the Science Department at South Philadelphia High School, we believe that by taking the mystery out of technology, we free students to work their own magic with educational resources. Through the use of computing tools, students who were passive learners actively create their own multi-media projects such as interactive ecology vocabulary, branching microbiology reports, or illustrated newsletters. The students' works are being used to instruct ESOL students and throughout the Health Academy and Environmental Studies programs.

Take the journey with us as we present through computer and slides (or possibly videotape) how our students use programs like *The Writing Center*, *HyperStudio*, and *HyperCard* along with scanner, CD-ROM, and laserdisc to create their magic.

The Art Students' Portfolio For The Multimedia Age

Anne Powers
Art Department Chair
Rockwood, TN

Abstract

At Tennessee's Roane State Community College, some art students are putting away their black leather portfolios and acetate filled "books" and are presenting themselves with new flair and versatility on video. In *Portfolio Preparation*, a course required for all art majors at Roane State, students are provided with the skills to produce their personal presentation on video and are helped with the content, design, and flow of the overall piece. All art students have access to a well equipped computer lab which employs the highest technology available in the Macintosh platform for 32-bit painting and illustration, pagination, animation, 3-D modeling, and video output.

The multimedia presentation enables the students to show much more depth and adaptability with his talent, a definite advantage in today's highly competitive world of art employment and education. The video media not only allows the art student to show traditional 2-D art which can be easily scanned into the presentation with photographic realism, but to also integrate exciting new facets into their presentation. In addition to comfortably paced "stills" of flat work like drawing, painting, illustration, photography, or any other 2-D media, more active animated sections may be added to create a new dimension. Sculpture or other 3-D work seen in a moving view from all sides, movies of conceptual or performance art, movies of the artist at work or talking about his work, animated illustration and painting, and 3-D modeling can all be integrated into this package. Sound or narration can then be added to support the overall feeling of the piece, and provide a unifying element.

For students interested in breaking into the rapidly growing multimedia field, video provides a natural showcase for his skills in animation, 3-D modeling, and music pacing. The student in Graphic Design or Illustration will add to his employability by showing his skills at work in the area of animated presentations, along with 2-D work. Packaging and books, previously difficult to handle in the traditional portfolio can be easily and effectively shown using animation and 3-D techniques. The change in portfolio philosophy is perhaps more drastic for the fine art student, who finds the ways in which he can present his ideas suddenly expanded. The production of this type of portfolio actually affects the student's attitude about himself as an artist...he sees himself not limited to 2-D or even 3-D and remains open to more levels of artistic expression. The student who previously might have been limited within dimensions as he concentrated on the development of a traditional portfolio now sees the possibilities in time, space, sound, and motion!

Video portfolios may be easily and inexpensively reproduced and left without concern with prospective employers, clients or schools...a big advantage over the single portfolio which is often needed in several places at one time! In the *Portfolio Preparation* class at Roane State, the design and production of the portfolio serves a dual purpose: a dynamic presentation vehicle for anything a student might consider art and a valuable learning experience in itself...both in perfect synch with the coming multimedia explosion.

This project is an educational venture, with no commercial purpose.

This abstract was taken from the author's originally submitted proposal

One Macintosh, Thirty Students, Drill and Practice, NOT!

Karen Thompson and Donna Holinga
Springfield School District #186
Buffalo, IL

Abstract

Technology will change and revolutionize the classroom. We have all heard the promises. We have all been excited by the prospects of change for teachers and students. How to use one computer effectively is a challenge, and the problem is not easily solved by the teacher just beginning to use technology. It requires not only specific teaching strategies and teacher training, but also a vision for what is possible.

One computer and 6 students, NOT!
One computer and endless teacher training, NOT!
One computer and a limitless budget, NOT!
One computer and throw out the curriculum, NOT!

One year-long third grade classroom project was a HyperCard stack we titled *All About Me*. Every year, third graders listed their favorites and told something about their family. This year the students completed a HyperCard card that asked for the information. The opening card displayed their picture (a still-shot camera was borrowed for two days), and then additional buttons allowed students to add information. During the school year students added cards that were descriptive paragraphs, Christmas wishes, KidPix drawings, historical events on their birthday, and a greeting in Spanish completed during their unit on Mexico. Students enjoyed reading about other students, liked watching the stacks grow, and were surprised at the end of the school year to see how much they had changed!

The stack was easy to use for a teacher new to technology, it fit right into the existing curriculum, it did not take extensive training to use, and both teachers and students enjoyed it. This shell stack has been modified and used in other classrooms for studying French speaking countries, sharing Presidential information, and collecting book reviews.

There will be many sessions telling you about the wonders of technology and many more giving you a vision for the future, but this session will give you some practical advice on where to begin. It will show you what to try the first year, and the changes you can begin to make in the curriculum in the years ahead. A HyperCard stack of the *All About Me* project will be available in exchange for a blank diskette. It is ready for you to add your own student data! If you can open a file on the Macintosh, then you are ready to begin!

This is not a commercial product or venture.

This abstract was taken from the author's originally submitted proposal

---

Civic Education Hypertext Project: From Curriculum Framework to Classroom Implementation

Charles S. White, Erika Berner, and Dean Nelson
George Mason University
Fairfax, VA

Abstract

Consistent with national reform movements across the full range of curriculum areas, the Center for Civic Education (Calabasas, CA) has developed a curriculum framework for the teaching of civics entitled *Civitas*. From this framework will spring a set of national standards for civics and government. This presentation will describe current work by faculty and doctoral students in the Center for Interactive Educational Technology at George Mason University to design a hypertext document for use by curriculum developers and teachers who wish to explore the conceptually complex knowledge base represented by Civitas. At the same time, we want educators to consider potentially powerful linkages among civics content, emerging national standards, and curriculum development. Future plans for hypermedia-based instructional materials for students will be discussed as well.

Projects (W3.12)
Multimedia

Technology and Multimedia in the Restructured Primary School

Cheryl Basham and Rosaland Henderson
Jefferson County Public Schools
Louisville, KY

Abstract

Jefferson County Public Schools has taken an initiative in instituting non-graded primary classes which include ages 5 - 8 as part of its restructuring efforts in elementary schools. Technology can be an integral part of the curriculum for schools with multi-age grouping since it allows for cooperative learning and team building while both meeting individual needs and accommodating a wide range of learning styles. This is accomplished by incorporating computers, scanners, graphics programs, videodiscs, and/or CD-ROMs into the curriculum.

In this session, the presenters will describe multimedia projects created by primary students using *HyperStudio*, *HyperCard*, various graphics programs, and peripherals.

This is currently a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

The Magic of Literature: Reading and Laser Discs

Peggy Remis
Regional Consortium for Education and Technology (RCET)
Chesterfield, MO

Jeanette Scheibal
Reading Coordinator
Kirkwood School District

Abstract

Samples of student work collected over the past 6 years show student response to children's literature is closely related to development. Levels of understanding and patterns of response emerge at various developmental stages which can help teachers choose appropriate literature and model meaningful response. With the addition of laser disc technology, high quality still and full motion video images can be used to enhance each child's experience with literature. The visuals build upon background knowledge and previous experiences of individual children to broaden the reader's understanding and interpretation of the text.

Laser disc technology supports literature practices by stimulating group discussions and interactions about both the content of the literature and individual insights, feelings, and opinions. The visual images, voice gestures, and actions provide a context that help to develop important strategies such as predicting/confirming, verification, and critical and creative thinking. The student's understanding of narrative stories is increased as the video images provide visual representations and help clarify information about the topic. The connections between reading and viewing provide a framework to enrich the student's own expression in writing, while the technology provides captivating experiences for each child to draw upon in the interpretation of the written text.

Put A Star In Your Classroom

Ivy Montoya
1993 Florida Instructional Technology Teacher of the Year
Miami Central High School
North Miami, FL

Abstract

This lively presentation is the product of two years of working with PRODIGY in the foreign language classroom, and is now supported by an IMPACT II education grant to include a cross-curriculum approach. The results of using PRODIGY in the foreign language classroom appeared in the December 1992 issue of *The Computing Teacher Journal.*

A great deal has been said about the power of international telecommunication in education. Unfortunately, the cost and necessary teacher expertise are limiting factors. There are alternatives to international communications, however, which respond to these problems. Telecommunications on a national basis can be an effective alternative. PRODIGY offers an economical, user friendly service with electronic mail and a multitude of features and real world information. This presentation will demonstrate how electronic mail can be used to enhance communications skills and promote motivation in several different subject areas.

Sample electronic mail projects and lesson plans will be distributed along with guidelines for teachers to use when planning electronic mail projects or information access and processing. Those present will have the opportunity of signing up for free software for PRODIGY as well as the first month of service free.

This project session is applicable to all subject areas and user levels in grades K - 12.

Using Quick Time To Help Preserve Native Languages

Richard Sgarlotti and Bruce Hanninen
Hannahville Indian School
Wilson, MI

Abstract

The Hannahville Indian School is located on a Potawatomi reservation and is the only Indian school in Michigan. In 1990, the school was a recipient of an Apple Crossroads grant, based on a proposal to use Macintosh computers in a whole language method of teaching. This included the use of much material on the Potawatomi and Ojibwe culture and language of the area. HyperCard stacks have been developed using traditional stories, stories and history from elders, and stories which students developed. Most stacks used audio, first from MacRecorder, and then with Audio Palette.

New stacks which have been developed can be easily used with any language. The written words and audio can be put into one card of the stack and appear in appropriate fields and buttons throughout the stack. These have been produced through collaboration with a local intermediate school district and Northern Michigan University.

Original plans had called for the production of a videodisc to be used with the stacks. However, with the introduction of Quick Time, the stacks have been enhanced with video of the elders speaking their native language and student produced "plays" using the language.

Funding of the development has been provided through a Department of Education Title V Indian Education grant, and stacks are available for distribution at no charge.

Teacher Training--Interactive

Michael Speziale, Christina Charnitsky, Michael Garzella, and Lynne LaFrance
College Misericordia
Dallas, PA

Abstract

Recent trends in school reform and the Regular Education Initiative (REI) have precipitated greater diversity among classroom populations. The more diverse a teacher's classroom becomes with respect to differences in students' ability levels, social skills, and educational experiences, the greater the demands on the teacher for content expertise and knowledge of pedagogical principles.

One of the problems that many teacher training programs have in common is the limited opportunities that trainees have in observing and practicing pedagogical skills in the context of a real classroom. While future applications of technology might yield "virtual reality classrooms" where teacher trainees can practice newly acquired skills, today's technology has provided us with the means to begin to approximate such experiences.

The Teacher Training - Interactive project has been designed as a training tool that approximates real world experiences of teachers. It ties together abstract pedagogical concepts and the classroom application of those ideas. The interactive laserdisc product is designed to provide clear explanations of research based teaching skills, contextualizing the instruction with video segments that demonstrate the skills being applied in real classrooms. The interactive nature of the program allows users to apply newly acquired pedagogical skills through various problem solving situations.

Projects (W3.13a)
Instructional Software

Social Studies Teaching About Religion Through Technology

Beth Gordon
UCLA / CAIP
Los Angeles, CA

Abstract

The *Teaching the History of Religion in the Schools* interactive multimedia project is being developed by the Center for Academic Interinstitutional Programs (CAIP) at the Graduate School of Education, UCLA and is being funded by the IBM California Partnership in Education and by CAIP. The product will be distributed free of charge to all California schools who request it. Our primary purpose is to meet the needs of teachers and students in grades 5 - 8 for instructional materials and pedagogical guidance in learning about the major religions in the world and their role in history, as outlined in the 1988 California State Framework.

The core of the content consists of six major religions (Buddhism, Christianity, Confucianism, Hinduism, Islam, and Judaism) covering from 4,000 B.C.E. to present. The history, geography, people, ideologies, ethics, and culture (including art and literature) will be addressed both for each individual religion and, in appropriate places, in a comparative manner. In addition, the study of Christianity will focus on sects important historically such as Lutheranism, Mormonism, Quakerism, Catholicism, and Evangelicalism. A geography based, active timeline and a database provide alternative methods of accessing the information.

Technically and pedagogically, this product emphasizes flexibility. The ability to use interactive multimedia to access information creates a dynamic learning environment which both motivates students and brings alive the stories of history. The development process is emphasizing an ability for the software to be used with or without the laserdisc while still maintaining its essential integrity. Writing and drawing abilities built into the software allow students to become actively involved with the content. Questions encouraging critical and creative thinking and expression are imbedded throughout.

Teaching religious history requires a sensitivity to and awareness of the students' individual perspectives. To help teachers, a tutorial is included which will address these issues and offer suggestions for ways to approach the content in a sensitive manner and to address the range of potential responses from the students.

In June, 1993, the majority of the software will be developed, and all of the software features will be functional. The final product, completed probably in August 1993, will consist of 12 - 15 megabytes of software, 1 CAV laserdisc, 1 teachers manual, and 1 tutorial disc. It runs on an IBM 286 or better and any laserdisc player which would be the equivalent or better of a Pioneer 4200.

This abstract was taken from the author's originally submitted proposal

Notebook Computers and the Implications for Education

Chip Kimball
Madera Unified School District
Madera, CA

Abstract

Notebook computers have taken the industry by storm. These computers should not be limited to the business user, however, as the implications for education both instructionally and fiscally are significant. Madera High School has piloted the use of notebook computers in the classroom and is experimenting with a teacher/student check-out program. Topics addressed include management, security, and implementation. The financial implications of implementing a "notebook computer" program will also be addressed as many facility problems and staffing/scheduling problems associated with computer labs may be adequately solved with notebook computer implementation.

Summer Computer Camp: A Place To Encourage Girls in Technology

Edith Kort
University of Rochester
Penfield, NY

Abstract

The Math, Science, and Computer Camp for Girls [sponsored by the Graduate School of Education and Human Development and the Susan B. Anthony Center for Women's Studies] at the University of Rochester provides an opportunity for girls to work with technology, science, and math in a non-traditional way. The camp is a two-week daytime summer program for girls ages 8 - 14 held on the campus of the University of Rochester. The purpose of the camp is to expose the girls to math, science, and computers in a relaxed atmosphere and to give them the opportunity to explore aspects of technology that interest them.

Each day the girls have one to two hours of uninterrupted computer time. They use a variety of software on Macintosh computers. Some of the computer work is structured instructional time, and some is "free choice," an option rarely encountered in school. They use word processing, graphics, HyperCard, scanning, as well as games with an educational focus. Software was chosen that relates to the sciences in a number of ways, such as using Flight Simulator along with an aviation presentation and scanning plant images from specimens gathered on a nature walk.

The sciences studied at camp range from computer science to nutrition, medicine to aviation, mathematics to biology. This is done through visits to scientific laboratories on campus and having guest speakers at camp. This exposes the campers to science in an authentic atmosphere. Campers see scientists as real people doing their jobs, with many women scientists serving as role models. They are exposed to a variety of careers and see that computers are a way of life for scientists in almost any discipline.

The camp experiences are well-planned curriculum with definite goals, supported by activities which are structured by activities which are structured to accomplish this without seeming like school. Goals for the computer "curriculum" include familiarity with the computer system including the server, the ability to create a simple HyperCard stack, the ability to use a graphics program, and experience with educational computer games such as Cosmic Osmo, Carmen Sandiego, and Math Blaster. Goals for the mathematics "curriculum" include working with fractions, planning strategies, graphing in a non-traditional way, and keeping with the spirit of the NCTM standards. There are also specific goals for the science aspects of camp, as well as some activities dealing with gender issues. Games and crafts are chosen to complement the math, science, and computer theme of the camp.

At this project session, I will give an overview of the camp and its goals, present some specific examples of camp projects and computer work, and show how a camp setting can make learning about technology fun and address special needs of girls in technology.

This abstract was taken from the author's originally submitted proposal

Projects (W3.14)
Emerging Technologies

Project Egret: Electronic Paradigms—E-Mail and "Live" Satellite Application in Education and Industry

Sally Lucke, Sandra McCourtney, and Zsuzsanna Ardo
EGRET International
Sarasota, FL

Abstract

Following a brief review of the literature, the presenters will demonstrate how learner-centered PC environments that provide national, international, and local on-line capabilities, wherein groups of students from geographically distant classrooms collaborate on content-based projects, places learning in a relevant meaningful context, promoting cultural diversity, language learning, and critical thinking.

"Let's Go Technology", Planning A Successful Program

Terryl Gonzales, Grace Hom, and Michele Parga
Los Angeles Unified School District
Los Angeles, CA

Abstract

The Los Angeles Model Technology Schools Project serves a population of 97% Latino in one of the lowest socioeconomic communities in the country. Many of our students are functioning on a very limited experiential level, and yet are expected to base their new learning on experiences that they have never had. The technology has helped us to increase our students level of experience by the use of multimedia that can bring new and exciting adventures into the classroom. We have found that through the use of authoring tools like HyperCard™ and Linkway™, that allow us to develop our own programs which interact with laserdisc, we are able to empower students daily by giving them tools that open up new worlds of knowledge and stimulate oral and written language experiences. It was always clear that a project which has significant impact upon students' capabilities in language arts could have far-reaching, positive consequences across all other curricular areas. We have successfully created bridges throughout the content areas of instruction.

Cost Effective Networking In The School Office

Anthony Sassi
Houston Independent School District
Houston, TX

Abstract

The presenter will summarize the Houston Independent School District's effort to network Macintosh computers and printers in school offices using a variety of networking protocols. This project presentation will provide attendees with the information they need to begin planning for the installation of a high-speed, low-cost computer network. The presenter will discuss the benefits of networking with Ethernet and how it can increase productivity when used with a file server containing school data. The presenter will also discuss the differences between hub and patch panel wiring schemes.

The main topic presented will be a method of wiring that enables the school to choose between two ways of networking using dual telephone jacks and inexpensive twisted pair wiring. Other items mentioned will include an overview of converting from Localtalk to Ethernet, choosing the appropriate wiring scheme, and installing network adapters. Cost considerations, ways of doing it yourself, and troubleshooting will also be discussed. The cost of such a configuration will be discussed, and the use of appropriate router and server software and hardware will be mentioned. Samples of the network wire, tools, and connector boxes will be brought for the audience to view.

This project is currently a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

---

Project IDEALS: Computer Network Simulation Around the World

David Crookall
University of Alabama
Tuscaloosa, AL

Abstract

This session will describe *Project IDEALS*. Funded by the United States Department of Education, the project provides an experiential learning environment based on a series of computerized network simulations, in which host and international students are brought together to become more effective cross-cultural communicators and develop awareness of global interdependence and environmental issues.

At the heart of this learning environment is a series of simulations, operated via computer networks, allowing communication among teams situated at diverse institutions around the world (e.g., in Germany, UK, USA, Russia, Latvia, Japan, Australia, and Canada). Teams use ordinary PCs to link into a central computer using specialized software.

Each session lasts about 14 weeks, comprising preparation, the simulation itself (and in which three debriefing/feedback periods are held), an in-depth debriefing, and follow-up work. A facilitator is in charge of each country team, provides guidance to the group on cross-cultural communication and group processes, and conducts the debriefing sessions.

A variety of on-line evaluation instruments are used to gather both quantitative and qualitative data, serving the simultaneous purposes of project evaluation, simulation evaluation, and immediate feedback to help learners gain from their experiences, both during and at the end of their simulation sessions.

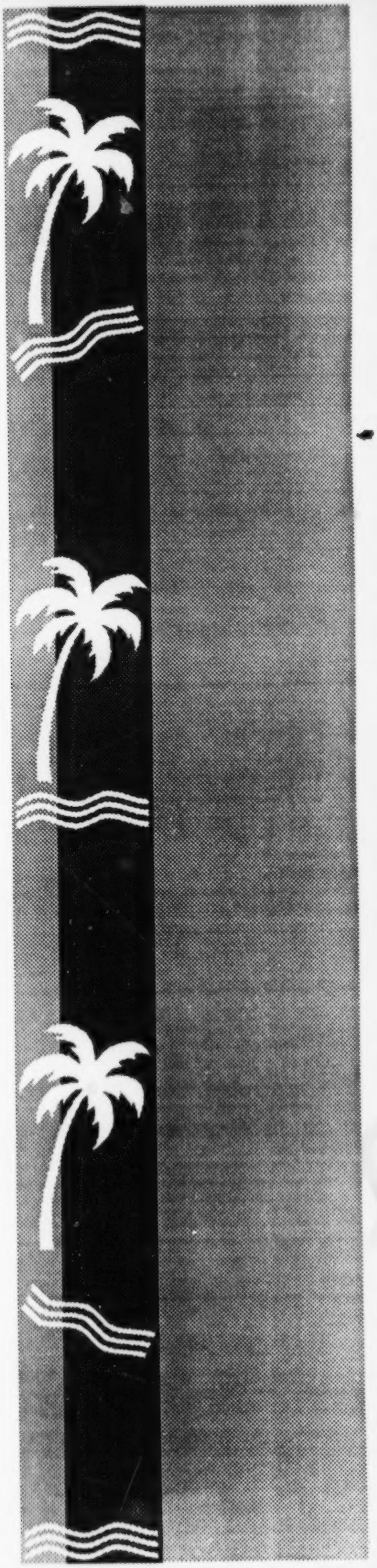
The results so far have been extremely encouraging, and can be gleaned from the following exchange between two participants:

Student A: Why do you keep pacing up and down like that?
Student B: Well, I think better like that.
Student A: What do you do in your other classes, then?
Student B: I memorize, not think.

This project is a non-commercial product or venture.

This abstract was taken from the author's originally submitted proposal

Presenter Index



Presenter Index

Abas, Zoraini Wati, 144
Abshire, Sheryl, 160, 309
Adamson, Eadie, 61
Adamson, Larry, 59, 164
Aguilar, Blanca, 259
Akin, Thomas A., 202
Akins, Anthony Storms, 47
Andelora, Sharon, 161
Anderson, Judy, 98
Anderson, Michael R., 245
Anderson, Susan, 37
Anderson-Inman, Lynne, 279
Andres, Yvonne, 38
Ardo, Zsuzsanna, 320
Aronin, Gene, 242
Au, Wing K., 80
Auck, Chuck, 61
Awerkamp, Barbara, 66
Bagwell, George, 101
Bailey, Doreen, 59
Baird, William, 279
Barbieri, Forest, 204
Barnett, Bill, 70
Barowy, William, 166
Barron, Ann, 106, 280
Basham, Cheryl, 315
Baumann, Jack, 65
Baxter, Robert L., 43
Beaver, John F., 246
Becker, Sandra, 238
Becnel, Shirley, 67
Beech, Marty, 110
Bell, Debra, 66
Beltrametti, Monica, 11
Benson, Kim, 305
Bentzen, Estelle, 212
Benz, Richard, 272
Bergeron, Eileen, 30
Bergmann, Rachelle, 138
Bernal, Ernesto M., 24
Berner, Erika, 314
Bernstein, Danielle R., 41
Bessman, Marcelle, 32
Best, Anita, 244
Bezjak, Alex, 272
Bias, Gene, 28
Biegel, John, 26
Bjork, Betty, 305
Black, John, 102
Blakeslee, Dr. George, 28
Blanch, Helen, 60
Blau, Jan, 57
Bleakley, Ann, 238
Bloker, Paula, 1
Boles, William, 268
Bork, Alfred, 168
Boucher-Owens, Barbara, 244
Boyd, J. R., 104
Brehm, Barbara, 98, 278
Brittain, Dave, 245
Brousseau, Georgia, 268
Brown, Allen, 277
Brownell, Gregg, 234
Brownell, Nancy, 234
Brumbaugh, Doug, 270
Brumbaugh, Ken, 57, 151
Bruwelheide, Janis H., 96
Bryson, Andy, 104
Burge, Kimberley, 30
Burkholder, Karla, 210
Burrall, Bill, 164, 240
Burton, Debra, 73
Butler, Roxanne Greco, 263
Byrd, Cathrine, 151
Cameron, Allan, 155
Cameron, Beverly, 60
Campbell, Nola, 162
Canter, Ruben, 4
Cantlebary, Sheila, 275
Capaso, Chris, 272
Carey, Chris, 57
Carey, Doris, 278-279
Carey, Regan F., 279
Carlson, Elizabeth, 204
Carr, Sherah, 101
Carraway, Jim, 268
Cassel, Lillian, 73
Cates, Ward, 65
Chait, Sharnee, 156
Chambliss, Carolyn, 66
Charnitsky, Christina, 317
Charp, Sylvia, 70
Chen, Shu-Hsien, 180
Chilton, Brad, 63
Chin, Sabrina Su-Fen, 269
Christensen, Rhonda, 162
Cicero, John A., 113
Clark, Bradd, 167, 214
Clarke, Fayette, 152
Clarke, Valerie A., 41, 252
Coffee, Roger, 68
Coffin, Edna, 312
Coil, Bob, 230
Coil, Pat, 272
Collmorgen, Dorris, 208
Conner, Constance M., 52
Connolly, Frank, 167, 244
Cook, Robert N., 206
Coorough, Randall, 236
Copen, Peter, 267
Cory, Shelia, 215
Cote, Paul, 36, 234
Crane, Beverley E., 26
Crawford, Chase, 111
Crisci, Gerald, 242
Croft, S., 34
Crookall, David, 321
Cullar, Wendy, 110
Cullen, David, 245
Cullum, Lynn, 309
Cumaranatunge, Chandima, 31
Cunningham, Vanessa, 263
Cuprak, Theresa, 230, 265
Daniels, Steven W, 138
Daniels, Tim, 5
Davey, Bill, 1-2
Davis, Doug, 138
Deal, Walter, 109
DeBose, John, 109
Denning, Janice, 269
Dick, Dan, 305
D'Ignazio, Fred, 165
Dillon, Jacqueline, 149
Dipinto, Vito M., 31, 60
Dixon, Scott, 154, 240
Dowd, Chris, 215
Doyle, Arthur, 235
Dries, Ron, 245
Dufour, John, 202
Dycus, Robert, 261
Eason, Michael, 70, 103, 275, 280
Ebeling, Matt, 149
Edwards, Carol, 163
Edwards, Jack, 309
Egbert, Candy, 261
Elnor, Nancy, 239
Engel, Gerald L., 3
Etheridge, Sandra, 58
Fagin, Barry, 116
Farragher, Pierce, 307

Fehr, Raymond, 162, 310
Ferguson, Dan, 59
Ferguson, Iain, 277
Feser, Cheryl, 242
Finigan, Sarah A., 32
Flores, Chencho, 102
Flyzik, Peter, 274
Folse, Bebbie, 269
Fons, Robert, 69
Fontaine, Anne, 232, 262
Ford, Mary Jane, 232, 262
Fornshell, George, 37
Francis, Leslee, 307
Freedman, Debra, 236, 269
Friske, Joyce, 71
Frost, Terry Cahill, 66
Furst-Bowe, Julie, 155, 261
Gaede, Owen, 110
Gagel, John, 2
Gallivan, Sharon, 65
Gardner, Charles T., 208
Garrett, Susan A., 205
Garzella, Michael, 317
Gaston, Greg, 99
Gau, Gerald E., 216
Gilmour, Suzanne, 150
Goedkoop, Mark, 162
Gonzales, Terryl, 320
Goodwin, Mary, 208
Gordon, Beth, 318
Gotterbarn, Don, 244
Goulian III, Dicran, 140
Gragert, Edwin, 267
Grandgenett, Neal, 63
Greenberg, R., 34
Griffis, Virginia, 268
Groppe, John, 113
Gross, Edmund, 236
Grott, Dave, 164
Gurwitz, Chaya, 222
Hall, Donald, 268
Halpern, Neomi, 222
Hamilton, Julie A., 171
Hammons, Kathy, 69
Hanchey, Cindy Meyer, 41, 255
Hancock, Guy, 239
Hancock, Vicki E., 29
Hanein, Shirley, 161
Hanninen, Bruce, 316
Hansen, Darylann, 307
Hardesty, Steve, 34
Hare, Karen, 107
Harper, Ed, 230
Harris, Genell, 37
Havens, Tammy, 263
Haverfield, Mary S., 101
Havholm, Peter, 72
Haviland, Kathleen, 232
Hehman, David, 239
Henderson, Rosaland, 315
Henriquez, Andres, 27, 154
Hesser, Lois Ann, 104, 159
Hibino, Stacie, 312
Hidaka, Kazuyoshi, 185
Hillman, Aubrey, 99
Hoffmeyer, Carl L., 24
Hofstetter, Fred, 111
Holinga, Donna, 314
Holt, Ric, 277
Holte, Jeff, 274
Hom, Grace, 65, 320
Honey, Margaret, 27, 154
Hoover, Jane, 275
Horn, Patricia S., 233
Hotchkiss, Phyllis, 106, 237
Howard, Madeline, 99
Howell, Joseph, 58
Hudson, Larry, 37
Huggard-McKinney, Kathleen, 212
Humphfus, Barry, 309
Huneke, Mary Coesfeld, 130
Hunt, Adrianne, 98
Hutchins, Cathy, 68
Hyde, Douglas, 155
Iannuzzi, Robert J., 245
Imhof, Heidi, 272
Ivers, Karen, 280
Jacobson, Michael, 259
Jancich, Helen, 137
Janik, Jacqueline, 158
Jansen, Paul, 305
Johnson, Larry, 108
Johnsonbaugh, Richard, 140
Johnston, Jerome, 312
Jones, Greg, 37
Jones, Jill, 230, 265
Jones, Mike, 100
Jost, Steve, 140
Jury, Patricia, 98
Kalfsbeek, Patricia, 69
Kay, Robin H., 74
Kelberg, Edward, 312
Kelly, Peggy, 278
Kelso, Janice, 99
Kerlin, James, 112
Kimball, Chip, 152, 318
Kinder, Peggy, 110
Kinstler, Ann, 275
Kirsch, Irwin, 70
Knezek, Don, 71
Knezek, Gerald, 162
Knoke, Peter J., 122
Koch, April, 237
Kock, Ries, 162
Kolvoord, R., 34
Kornegay, Diane, 66
Kort, Edith, 319
Kramer, Kevin M., 269
Kratochuil, Shirley, 274
Kreller, David, 100
Kung, Mou-Liang, 41
Lado, Paige, 58
LaFrance, Lynne, 317
Lamb, Annette, 212, 277
Lamb, Charles E., 270
Lan, William, 233
Land, Michael, 106, 237
Landry, S., 167, 214
Lawson, Carylie, 96
Lawson, John D., 41, 279
Lee, Judy, 158
Lenkway, Pete, 309
Leonard, Janelle, 70
Leonard, Pat, 245
Levin, James, 259, 295
Lewis, Forbes, 3
Lewis, Jesse C., 41
Liao, Thomas T., 33
Lidtke, Doris, 243
LiSanti, Barbara A., 52
Loomis, Cyndy, 100
Lopotka, Mike, 202
Lough, Tom, 109
Lowd, Beth, 267
Lucke, Sally, 27, 320
Madison, Sandra, 216
Magisos, M., 34
Mancuso, Donna, 160
Manson, Diane, 160, 309
Marcus, Stephen, 2
Martin, Larry, 100, 153
Masie, Eliot, 163
Masullo, Miriam J. Salman, 291
Maurer, Mathew M., 211
Maury, Kathleen, 157
McBride, John W., 24
McClurg, James, 104
McClurg, Patricia A., 104, 203
McCourtney, Sandra, 27, 320
McGrath, Diane, 310
McHaney, Larry, 99, 206
McIsaac, Donald N., 21

McLellan, Hilary, 310
McMillan, Katie, 154
Meade, Terri, 35
Merickel, Mark L., 91
Merritt, Susan M., 39
Meskill, Carla, 212
Michaud, Noreen, 108
Mielke, Angela, 102
Miles, Gail, 244
Miller, Charles, 138
Miller, Inabeth, 42
Milne, Lynda, 312
Misiak, Sue, 275
Mitrani, Marco, 242
Mizell, Al, 104, 159
Montoya, Ivy, 316
Moore, David, 162
Moore, William R., 43
Morgan, Jerry, 70
Morrison, Joyce, 231
Mortenson, Robert, 63
Mulder, Michael, 167, 214
Muise, Steve, 202
Munson, Dorie, 106, 241
Murray, Kathy, 276
Nabi, Doris, 64
Nahouraii, Ez, 166, 214
Nanny, Margo, 212
Napak, Brian, 109
Neely, Margery, 31
Nelson, Bruce, 245
Nelson, Dean, 314
Newhouse, Steve, 309
Newman, Denis, 72
Newsom, John, 215
Noel, Lynn, 211
Noll, Steven, 1
Norgaard, Sandi, 164
Null, Linda, 5
Nuñez-Cruz, Jaime, 237
Oates, Rita, 163
Olds, Henry, 4, 213
Olivier, Ronna, 31
Olmstead, Phyllis, 37
Osborne, Tim, 100
Palermo, Judith, 272
Parga, Michele, 320
Parker, David L., 16
Patt, Y., 167, 214
Peet, Bill, 213
Peet, Libby, 213
Pelfrey, Ty, 59
Petrone, Tina, 312
Phinney, Marianne, 237
Pinson, Rachel, 97
Place, Ron, 61
Poage, Julie A., 106, 241
Poirot, James L., 57
Polansky, Fred, 260
Pollock, Henry, 111
Pontius, Ron, 24
Powell, Kathy, 35
Powers, Ann, 313
Pugliese, Madaline, 1
Pusins, Dolores, 205
Rahming, Martha, 111
Rana, M. Akraam, 24
Randall, Linda, 276
Reed, Margaret, 99
Reese, Paul A., 72
Reeve, Robert H., 24
Reeves, Perry, 3, 71
Rehfield-Pelles, Kathy, 68
Remis, Peggy, 315
Repman, Judi, 211, 233
Resta, Paul, 151
Reyes, Alejandro, 155
Reyes, Alex, 242
Reynolds, Jean, 208
Rhoades, Bronwyn, 100, 153
Ricci, Glen, 27
Richards, John, 4, 166
Riecken, Ted, 307
Riel, Margaret, 164, 284
Rieth, Herbert, 149
Riley, Donna, 309
Roberts, Nancy, 166
Roblyer, M. D., 106
Rogers, Al, 38
Rosen, Marian, 62
Rosenberg, Donna, 157, 306
Rosenberg, Linda H., 226
Rosenthal, Laurie, 102
Roth, R. Waldo, 72, 244
Rowe, Patricia, 157
Rusk, Natalie, 209
Russell, Ron, 234
Sachter, Randy, 207
Sacry, Jude, 97
Saga, Hiroo, 108
Sanders, Jo, 163
Sansing, Mike, 61
Sassi, Anthony, 321
Scalise, James, 29
Scarbeau, Brian, 27
Scarborough, Harriet, 103
Scheibal, Jeanette, 315
Schleifer, Neal, 194
Schmid, Susan, 309
Schmidt, Denise, 25, 150
Schneider, Robert H., 5
Schouten, J. Fred, 260
Schrum, Lynne, 4
Seminoff, Nancy E., 306
Senn, Gary J., 105
Sgarlotti, Richard, 316
Shelly, Barbara, 25, 105, 150
Sherwood, Lorraine, 164
Shih, Mei-Yau, 235
Shorey, Denise, 24
Sidovenko, Betsy, 275
Silverman, Gene, 263
Silverman, Stan, 263
Simmons, W. Eugene, 231
Simms, Lottie J., 264
Sloan, Sally, 71
Smith, David, 100, 153
Smith, Larry, 245
Smith, R. Michael, 262
Spatz, Donna L., 209
Spencer, David, 211
Speziale, Michael, 317
Sridhar, Mythili, 295
Stafford, Carl, 265
Stapleton, Clinton E., 288
Stearns, Peggy Healy, 273
Steinfeldt, Richard, 274
Stephenson, Chris, 277
Stewart, Larry, 72
Stovall, Randall, 236
Strom, R., 34
Strudler, Neal, 278
Sumrall, William, 242
Swan, Karen, 212, 242
Swanson, Allen, 103
Swayne, Maria, 107
Sweeney, Jackie, 137
Sweetman, Edward, 232
Tavares, Maria, 107
Taylor, Harriet, 71, 277
Teague, G. Joy, 41, 252
Temkin, Kenneth, 36, 234
Terayama, Chiyoko, 108
Thomas, Julie, 109
Thomas, LaJeane, 71
Thompson, Ann, 25, 150, 171
Thompson, Karen, 314
Thornton, Becky, 27
Thurber, Bonnie, 60
Thurston, Linda, 269
Tinto, Patricia, 25, 105
Todd, Nancy, 69

Topp, Neal, 25, 150
Trainor, Marilyn, 150
Tu, Jho Ju, 273
Turner, Sandra V., 31
Tuscher, Leroy, 238
Tuttle, Harry, 215, 274
Uckotter, Ken, 308
Urrutia, Joanne, 103
Van Dyke, Mary, 203
Varma, Indu, 175
Varma, P. K., 175
Verschelden, Cia, 269
Viau, Elizabeth Anne, 271
Vickers, Jay, 240
Viner, Mark, 310
Vockell, Edward, 137
Volker, Roger, 301
Wagner, Roger, 40, 71
Wakim, Nagi, 41
Wall, Marilyn, 164
Wallace, Julie, 205
Waugh, Michael, 278
Webster, Sally, 167
Weiner, Cheryl, 275
Weller, Herman, 233
Wepner, Shelley B., 306
Weroha, Seree, 31
Whelan, Carol Scott, 232, 262
Whitaker, Elizabeth, 98
White, Charles S., 314
White, James E., 32
White, Linda M., 311
Wiebe, James, 71
Williams, Bard, 101
Williams, Catherine, 24
Williams, Robert, 202
Williams, Sam, 312
Wilson, Carol W., 134
Wilson, Jeri, 271
Wolf, Marty, 69
Yan, Wenfan, 241
Yoder, Sharon, 266, 277
Yoshimura, Satoru, 185
Young, Eileen Boyle, 156
Zarach, Nancy, 25, 105
Zimpfer, Pamela, 64, 110
Zirkler, Dieter, 234

Subject Index

Subject Index

ACM, 39, 73, 112, 135, 226, 255

Aldus PageMaker, 212

Apple, 1, 34, 57, 66, 152-153, 202, 223-224, 260, 272-273, 275, 309, 316

artificial intelligence, 16-17, 53, 226

ASCUE, 72

multilingual education, 65, 98-99, 102, 259

CAI (computer assisted instruction), 29, 33, 52, 62-63, 69, 86-87, 92, 105, 144-147, 231, 242, 295-296, 298-300, 301

CAUSE, 8, 15, 47, 50-51, 77-78, 126

CCSC, 244

CD / CD-ROM, 24, 27, 28, 40, 68, 98, 102-103, 106, 119, 158, 203, 204, 249, 260, 263, 272-273, 302-303, 309, 312, 315

computer labs, 31, 43-46, 58, 73, 101, 103, 124, 130-132, 138, 145, 147, 197, 208, 227, 229, 255, 257, 264, 279, 313, 318

databases, 6-7, 17-19, 21-24, 32, 36, 40, 54-55, 59-60, 63, 67, 72, 103, 105, 110-111, 124, 128, 144-145, 152, 172, 202, 209, 217, 226, 231, 233-234, 238, 248, 263, 266, 272-273, 280, 282, 292, 302, 307, 318

distance education, 12, 37, 96, 104, 108, 122-124, 127, 129, 159

ECMI, 41

educational software, 34, 49-50, 99, 102, 151, 272

EDUCOM, 167, 244

Eduquest, 276, 311

E-mail, 5-9, 13, 37, 63, 72, 105, 117, 123, 155, 159, 168, 172, 216, 240-241, 259, 266, 280-281, 288-290, 316

emerging technologies, 8, 63, 91, 104, 249, 320

ESOL programs, 102-103, 237, 312

ethics, 5, 8-19, 39, 86, 167, 168, 233, 244, 318

geography, 27, 36, 124, 134, 155, 234, 318

global education, 162

HyperCard, 1, 28, 30-31, 66, 98, 102, 107, 117, 146, 152-153, 204, 209, 232-233, 237, 240, 259, 262-263, 272, 282, 296, 299, 301-304, 307, 309-310, 312, 314-316, 319-320

hypermedia, 30-31, 59-60, 63, 66, 68, 71, 104-105, 113-114, 232, 242, 266, 296, 298, 301-304, 310

HyperStudio, 40, 98, 301-303, 312, 315

IBM, 14, 16, 19, 27, 29, 47, 113, 125, 139,140, 145-146, 165, 185, 205, 216, 270, 276, 293-294, 308, 311

IEEE, 125, 166, 214

image processing, 34, 114, 118, 140, 142-143, 203

instructional applications, 26, 37, 57, 61, 65, 98, 100

instructional software, 32, 67, 263, 305, 318

interactive software, 43

Internet, 5-19, 38, 63, 72, 97, 153, 154, 207, 240, 267, 287, 308

ISTE, 4, 71, 215, 244-245, 277, 278

LAN / Local Area Networks, 1, 6-7, 12-14, 26-27, 32, 35, 41, 49, 54, 65-66, 68, 74, 77, 80-84, 92, 96-97, 113, 125, 128, 145-146, 155, 206, 208, 224, 227, 249, 256, 284, 295-296

LARC, 157

LD / SLD programs, 2, 151

Linkway, 98, 113, 146, 205, 301, 311, 320
literature, 27, 49-50, 65, 72, 78, 106, 131, 168-169, 180, 210-211, 273, 315, 318

LOGO, 61-62, 80-87, 156-157, 207, 230, 264

Macintosh, 24, 57, 74, 76, 118-119, 138-139, 140, 158, 181, 197, 205, 224, 227, 237, 259-260, 271, 272, 282, 299, 313-314, 316, 319, 321

Math, 16-17, 20, 22-23, 25, 30, 32, 34, 42, 53, 58, 61, 63, 66, 74-76, 78, 80-82, 86-87, 99, 105, 114, 119, 122-124, 134, 139, 157, 166, 172, 185-186, 202-203, 204, 212, 214, 216, 222-223, 225, 228, 232, 239, 252, 256-257, 262, 263, 270, 272, 275, 277, 284, 291, 303, 305, 319

multimedia, 24, 27, 28-29, 31, 32, 40, 50, 58, 59-60, 65-66, 72, 98, 100-101, 104, 107, 113-115, 116-119, 152-153, 158, 165, 203, 204-205, 212, 232, 236-239, 259-260, 262, 263, 266, 271, 273, 275, 276, 277, 294, 296, 301-302, 307, 309-311, 312-313, 315, 318, 320

music, 27, 42, 102, 117, 119, 138-139, 178, 209, 232, 254, 260, 265, 273, 301-302, 304, 305, 313

NASA, 41, 153, 203

NECC, 25, 167

networks / networking, 4, 5-9, 12-14, 23, 25, 41-42, 53, 63, 68, 72, 96, 100-101, 105, 110, 122-123, 125-129, 132, 134, 144-145, 151, 153, 154-155, 158, 164, 167, 171-172, 174, 176, 197, 205, 206, 208, 215, 216, 222-224, 235, 240, 244-245, 249, 259, 263, 266, 267, 268, 272, 274, 276, 280, 284-287, 288-290, 305, 307-308, 321

notebook computers, 24, 245, 279, 318

programming, 8, 19, 39, 61, 75-78, 80-90, 113-115, 119, 124, 134-135, 144, 156, 158, 172, 217, 222, 224-225, 226-228, 230-231, 239, 252, 254, 255-258, 263-264, 265, 277

QuickTime, 28, 31, 40, 59, 66, 107, 117-118, 237, 296, 309-310

research, 2, 4, 5-9, 11, 13-14, 21-23, 28, 30-31, 35, 37, 41-42, 49, 57, 59-60, 64, 66, 74, 76-78, 80-87, 93-95, 99, 100, 103, 105, 108, 116, 119, 123, 125, 128-129, 130-133, 134, 144-145, 147, 151-152, 154, 157, 160, 166, 171, 173-174, 180-182, 184, 185, 194, 196-199, 205, 207, 208-209, 211, 234-235, 238, 240, 243, 249, 253, 255, 257-258, 261, 265, 272, 280, 284-285, 287, 288-290, 291, 294, 295, 298, 300, 304, 305, 307-308, 312, 317

restructuring, 1, 4, 100-101, 110, 151-153, 215, 237, 245, 256, 274-275, 288, 307,310,315

robotics, 109, 135, 207, 209, 226, 230, 263

satellite communication, 37, 42, 96, 240, 267, 280, 320

science, 3, 5, 7, 16-17, 19-20, 24, 27, 30-31, 32, 34, 39, 42, 47, 60, 61, 65-66, 67, 71, 72-73, 84, 96, 98-99, 100, 104-105, 107, 113-115, 116-119, 122, 128-129, 131, 134-136, 138, 140, 150, 153, 154-155, 156, 166-167, 172, 181, 202-203, 206-207, 214-215, 222-223, 225, 226, 228-229, 232-233, 239, 242, 244, 252-254, 257, 259, 261, 263-264, 272, 275, 277, 287, 291-292, 294, 300, 301, 303, 306, 307, 310, 312, 319

SCS, 4, 42, 72, 166

SIGCSE, 73, 255

SIGCUE, 41

SIGTE, 278

SIGUCCS, 9, 112

simulation, 4, 26, 33, 42-43, 45, 60, 72, 114-115, 118, 160, 166, 205, 225, 239, 280-283, 321

special populations, 98, 208

spreadsheets, 24, 33, 63, 74-78, 103, 105, 124, 138-139, 161, 209, 217, 224, 233, 248, 263, 302, 307

teacher training, 1, 24, 57-58, 63, 67, 69, 104, 106, 145, 149, 151, 158, 199, 261-262, 267, 314, 317

telecommunications, 4, 27, 30, 38, 63, 96-97, 98, 101, 123-125, 129, 154-155, 158, 160-161, 164, 170, 173, 175, 179, 203, 205-206, 235, 238, 240-241, 242, 245, 249, 263, 267, 272, 280-282, 284, 287, 307, 316

telecomputing, 4, 72, 267, 286-287, 290

testing, 5, 8, 19, 21, 23, 29, 30, 43-46, 55, 67, 72, 80, 83, 91-92, 94, 97, 102, 104, 110, 117, 126, 128, 130-131, 133, 135, 146-147, 156, 181, 194, 196-198, 202-203, 225, 227-229, 231, 235, 256, 284, 297, 301-303, 312

textbooks, 29, 31, 32, 53, 70, 113-114, 130, 135-136, 139, 152, 185, 227, 310

videodiscs, 3, 31, 68, 71, 104-105, 107, 203, 236, 262, 269, 273, 298, 300, 301-304, 309-310, 315-316

virtual reality, 2, 50-51, 91-95, 209, 317

workstations, 2, 9, 13-14, 54, 68, 82, 91-94, 106, 118, 128, 138, 222-224, 227, 229, 260, 261, 268

writing, 7-8, 14, 16-18, 21-23, 29, 32, 48-49, 58, 60, 61, 65-66, 68, 75, 78, 82, 98, 103, 107, 118-119, 124-129, 130-132, 135, 139, 140-142, 165, 168-169, 175, 178, 181, 194-199, 203, 205, 208, 210-211, 213, 222-223, 225, 238-239, 252-253, 256, 259, 261, 264, 265-266, 269, 272-273, 279, 280, 284-287, 289, 294, 301-303, 306, 308, 310, 312, 315-316, 318, 320